SUPPLEMENT—AUGUST 26, 1949

THE ENGINEER

Engineering and Marine Exhibition at Olympia.

DESCRIPTIVE SUPPLEMENT No. 1

THE seventeenth Engineering and Marine Exhibition at Olympia, London, was opened yesterday, Thursday, August 25th, and will remain open daily until Saturday, September 10th. This exhibition continues to grow in size and importance, and this year it has been necessary for the organisers to reserve all three Olympia halls to accommodate the products of the 500 and more exhibitors. The welding industry is once again well represented in a special section of the exhibition devoted to its plant and equipment.

As in previous years, the members of a large number of institutions and societies have been officially invited to visit the exhibition. This year for the first time the organisers are also inviting parties of employees from engineering factories and offices to attend the exhibition free of charge. This step has been taken to further a proposal that the theme of this year's exhibition shall be "production efficiency is the road to national recovery." It is hoped that by giving employees an opportunity to see the finished products to which they have contributed their efforts they will be stimulated to a greater interest and enthusiasm. At the same time, such products will be seen and compared with those of other works and the foundations of a healthy competitive spirit amongst the workers in British industry may be laid.

Turning to the exhibits themselves, it will be seen from this Supplement, another which will follow it next week, and the descriptions in the columns of THE ENGINEER, that practically all the main branches of the British general and marine engineering industries are well represented. Notable exceptions are, of course, the machine tool, aircraft and automobile industries, each of which has its own special exhibition.

At a first visit the impression may be gained that there are not many new developments to be seen at the exhibition. If it is safe to judge by the material made available to us to prepare this account before the exhibition opens, that impression may well be a correct one. But, after all, the major factors in the advance of engineering design are not so much sudden and surprising changes, but those minor improvements that are made year by year. They are so small in themselves that it is not until someone reads a paper or presents a lecture reviewing the progress made in some field of engineering over a decade or two that we realise what major changes have in fact been brought about by these continual minor improvements.

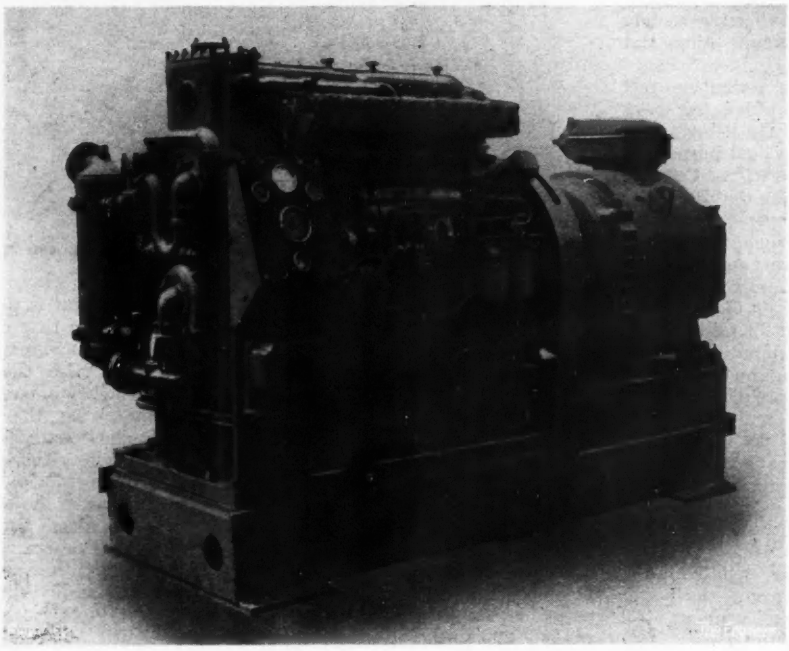


FIG 1—100 B.H.P. AUXILIARY MARINE OIL ENGINE—A.E.C.

The machines of to-day are recognisably similar to those of twenty years ago. Yet how very different they have become! Thus those who visit Olympia, whether or not they find any developments that can truthfully be claimed to be "outstanding" will certainly find on every stand evidence of that improvement that is constantly in progress. Nor are those improvements dictated merely by changes in fashion. They are not ephemeral, not made merely for the sake of change. For in engineering design, although appearance is certainly a matter that is studied, it is the practical value of a change that is much more important.

We are sure that everyone interested in the development of land and marine engineering will find much of interest at this exhibition. The object of our articles is to review the exhibits in the hope that our descriptions may help those who can visit the exhibition and to provide for others unable for one reason or another to go to Olympia information about some of the more interesting plant on show.

A.E.C., LTD.

The principal exhibits on the stand of A.E.C., Ltd., Southall, Middlesex, are a ship's auxiliary diesel-electric generating set, shown in Fig. 1, and a stationary engine, with clutch and gearbox, coupled to a wire line coring reel for use in oilfield work.

The marine auxiliary engine, which is coupled to a B.T-H. 40-kW, 115-V d.c. generator, is of the six-cylinder, 9·6 litre type. It has a continuously rated output of 100 b.h.p. at 1500 r.p.m., the bore being 4·72in and the stroke 5·59in.

The one-piece alloy iron cylinder block of the engine is fitted with renewable dry liners, and there are two interchangeable cylinder heads, each covering three bores. These heads incorporate A.E.C.-Ricardo "Comet" Mark III combustion chambers, renewable exhaust valve seatings, valve gear, injectors and heater plugs. The valve gear is enclosed by detachable cast iron covers. A cast iron exhaust manifold is water jacketed and is provided with a detachable cover plate extending its whole length. Rockers carried on the cylinder heads actuate the valve gear and the bronze bushes in which the rockers operate are lubricated through hollow rocker shafts. The push rods operate the rockers through ball-ended adjusting screws and are themselves actuated by mushroom tappets having chilled iron faces.

The camshaft of the engine is supported on five intermediate bronze bushes and a combined journal and thrust bearing at the forward end. A balanced drop forged crankshaft is carried in seven main bearings of which the centre, front and rear are lengthened to impart a greater degree of rigidity to the shaft. The fly-wheel is fitted on a heavy flange at the rear end of the crankshaft, and a keyed extension to the forward end of the shaft can be used to

drive an auxiliary requiring up to 12 h.p. at 1500 r.p.m.

A multi-plunger cam-operated fuel injection pump has a centrifugal variable-speed governor attached to its rear end, and this governor is connected to the throttle control gear by means of a lever and cable. Fuel is fed to the pump by a small positive action plunger fuel lift pump equipped for hand priming.

The engine has two similar but oppositely handed centrifugal water pumps, and their stainless steel impeller shaft is integral with the timing gear shaft. These pumps discharge about 30 gallons of water per minute against a head of 15ft at moderate engine speeds. A closed fresh-water-cooling system uses salt water as its cooling medium.

The A.E.C. type "A 211" stationary oil engine, which has been developed for oilfield duty, is shown in Fig. I in the Art Supplement. This six-cylinder, 9·6 litre engine is fitted with a heavy single-plate clutch and a four-speed and reverse gearbox. It has a continuous rating of 100 b.h.p. at 1500 r.p.m., and an intermittent rating of 125 b.h.p. at 1800 r.p.m. The design of this engine closely follows the same lines as the marine engine. It has, however, a large capacity radiator, incorporating oil cooling elements, which, in conjunction with an engine-driven fan and a thermostatically controlled system, ensures effective cooling under a wide range of temperature and tropical conditions.

The engine is coupled to a wire line reel for coring and swabbing, which has been developed by the Woodfield Hoist Company, of Rochester, Kent, for the dual purpose of coring and well servicing operations. Controls for the engine and the reel are centralised for efficient handling from the operator's seat.

The Woodfield reel has a single line operating depth of 12,000ft for coring and is capable of well servicing 5000ft of 2½in tubing. The drum will spool 12,000ft of ⅜in diameter line and the gearing is arranged for raising loads from 12,850 lb at 196ft per minute to 2000 lb at 1400ft per minute, the loads and line speeds being computed from the bare drum.

The reel is fitted with a drum friction clutch operating on 100 lb per square inch air pressure, which engages a free rolling drum mounted on large anti-friction roller bearings. Fully compensated, compressed-air-assisted wrap brakes operating on large dual paths are fitted.

The whole equipment is mounted on a substantial steel skid frame and the power unit is provided with an independent steel skid frame for ease in dismantling.

W. H. ALLEN AND CO., LTD.

Representative examples of power generating plant, pumping machinery and electrical equipment for marine, industrial and public service, as manufactured by W. H. Allen and Co., Ltd., Bedford, are exhibited on the company's stand.

One of the five circulating water pumping units for the British Electricity Authority's West Ham power station is on view. Each of these vertical, motor-driven pumps is designed for an output of 23,700 gallons per minute against a total head of 61ft and is direct driven by a 550 h.p. squirrel-cage, three-phase, 50 c/s, 3000-V motor running at 589 r.p.m.

A photograph reproduced in the accompanying Art Supplement (Fig. XVII) shows a general view of the unit assembled in the maker's works. The pump, which has suction and discharge branches of 39in diameter, is of the normal double-suction design, with a casing of cast iron, impeller of "Staybrite" steel and shaft of nickel steel fitted with renewable "Staybrite" steel sleeves.

Two grease-lubricated sleeve bearings carry the shaft, the bottom bearing being situated inside the pump casing and the top bearing being housed in an external bracket. The pump shaft is rigidly connected to the motor driving shaft, the total load on the rotating parts of the pump being carried by a Michell-type thrust bearing fitted in the motor.

It will be seen from the illustration that the motor is mounted on a short pedestal fixed to the top of the pump—a compact arrangement which leaves ample space for inspection and dismantling. For this purpose the casing is split on the vertical centre line, with a machined bolted joint, the suction and delivery branches being arranged on the fixed section of the pump to allow the unit.

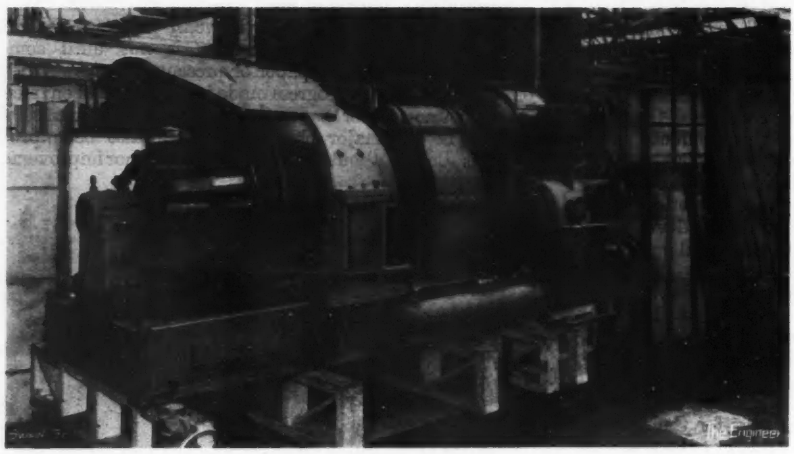


FIG. 2—750-KW "AWLINWUN" MARINE AUXILIARY GEARED TURBO-GENERATOR—ALLEN

to be opened up for inspection without breaking pipe joints.

The largest exhibit on the stand is a 750-kW "Awlinwun" geared turbo-generator, complete with auxiliary equipment, including mechanically driven condensate extraction pump, motor-driven circulating pump and steam jet air ejector. This equipment, as illustrated herewith, is typical of the Allen range of self-contained generating units for marine use, and comprises a multi-stage impulse turbine with one two-stage velocity-compounded wheel and seven pressure-compounded wheels, driving through single-reduction double-helical gearing a compound-wound, 220-V d.c. generator, the turbine running at 7000 r.p.m., geared down to a generator speed of 900 r.p.m. The turbine is designed for a steam pressure of 400 lb per square inch, superheated to a total temperature of 700 deg. Fah., and it is also suitable for operating with the maximum boiler conditions of 450 lb per square inch, 750 deg. Fah.

The turbine is mounted upon its self-contained, 825 square foot surface condenser, which is designed to give a vacuum of 27½in Hg. with a sea water temperature of 80 deg. Fah. The single-suction condensate extraction pump is mechanically driven through gearing from the steam end of the turbine, the vertical drive incorporating two flexible couplings to compensate for unequal expansion between the turbine and condenser.

The air pump comprises a two-stage steam jet ejector with surface inter and after-cooling, the tubes being in the form of a U, thus dispensing with the necessity for a floating header.

A separate Allen vertical motor-driven circulating water pump is employed with this turbo-generator, the duty of the pump being 1065 gallons per minute against 20ft total head. The pump is driven by a 9·75 h.p. enclosed ventilated drip-proof d.c. motor at 760 r.p.m.

Connections are incorporated in the condenser shell to take 4000 lb per hour of exhaust steam from the main feed pump, and 2700 lb per hour drains from the ship's services. The condenser is provided with a large underneath sump, which enables it to de-aerate satisfactorily all incoming drains, &c., and the air ejector is proportioned to deal with any necessary excess air. A Weir closed-feed valve is provided for use with the set

The turbine governor gear is of the leverless oil relay type, in which there is a complete absence of pins, levers, fulcrums and other parts subject to wear. An automatic thermostat is provided on the high-pressure gland, so that no adjustments are necessary to the gland sealing steam, despite changes of load. Also, the gland vents are led to the secondary stage of the air pump, thus greatly improving the habitability of the ship's engine-room. The set is fitted with a 2in warning relief valve with a back-pressure tripping device, which will shut down the turbine in the event of the exhaust pressure rising above atmospheric.

This design of turbo-generator set has an entirely flush underneath surface, thereby considerably simplifying the ship's seatings and greatly facilitating erection on board.

The Allen d.c. generator, which is designed for parallel operation, is a marine open single-pedestal bearing, compound wound machine, with drip-proof canopy protection over the commutator end. It is mounted upon the main fabricated base plate, bolted up to the base under the gearcase, and the frame and bearings are split on the centre line to facilitate erection and dismantling. Lubrication of the bearing supporting the armature shaft is provided from the turbine oiling system, due precautions being made to prevent creepage of oil along the shaft.

In order to minimise the risk of circulating currents due to magnetic stray fields, the bearing pedestal is electrically insulated from the base plate. Control of the generator voltage is provided by a hand-operated shut regulator arranged for back-of-board mounting.

NATIONAL GAS AND OIL ENGINE COMPANY, LTD.

The engines to be seen upon the stand taken by the National Gas and Oil Engine Company, Ltd., of Ashton-under-Lyne, are predomin-

antly for marine use. The main exhibit is one of the company's "R4AV8" eight-cylinder, pressure-charged engines, which has a rated output of 466 b.h.p. at 500 r.p.m. This engine is stated by the makers to be capable of running up to 900 r.p.m., but for marine purposes its speed is restricted to 600 r.p.m. Its design is such that it will fulfil the requirements of a marine auxiliary set, as shown in Fig. 3, and by the provision of drives embodied in the engine will form a propulsion unit with the usual bilge and water circulating pumps. An extra drive is provided so that, if necessary, two lubricating oil pumps can be fitted or alternatively these pumps can be used for oil pumps to permit dry sump lubrication, if this is preferred.

The engine is actually a development of the company's "RA" type, the principal changes in design being the introduction of the four valve head and the casting of the column in such a way that the liners fit into cylinders instead of rectangular spaces. This arrangement permits controlled cooling of the cylinder liner, and by it the water is directed round the liner by means of ribs.

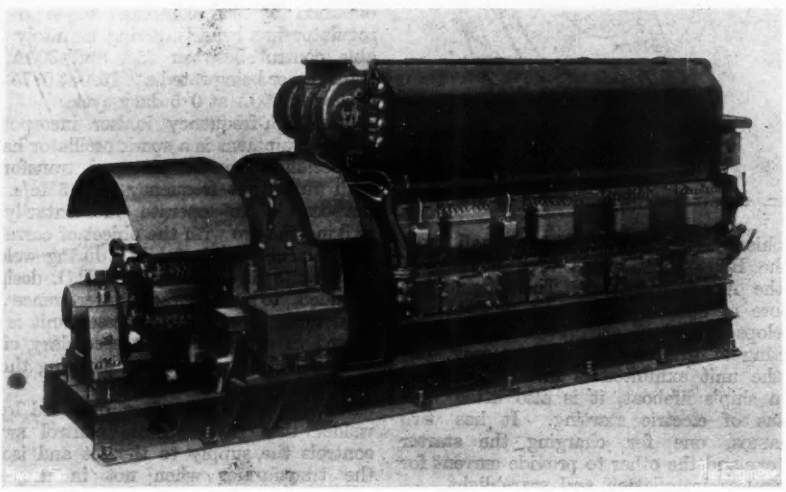


FIG. 3—466 B.H.P. MARINE AUXILIARY ENGINE—NATIONAL

A propulsion unit on this stand is the engine fitted with a hydraulically operated reverse reduction gearbox, illustrated in Fig. III in the accompanying Art Supplement. The rated output at the flywheel is 132 b.h.p. at 800 r.p.m. and at the propeller shaft 124 b.h.p. at 400 r.p.m. The engine has two camshafts and four-valve cylinder heads and for marine purposes its speed has been limited to 1000 r.p.m., although for special requirements it can run at 1200 r.p.m. This unit is exhibited driving a propeller and running up to full speed. In front of the gearbox a bridge has been built and fitted with steering wheel binnacle, compass and engine controls, which are mounted on a quadrant.

One of the company's "DAA5" five-cylinder engines is shown arranged as a compact generating set complete with radiator and having an output of 37½kW with a speed of 1500 r.p.m. It can be started by hand or by means of cartridge in a Plessey starter and is intended for installation in the steering engine-house for use in case of emergency. Should the main engine-room have to be vacated due to accident, such as fire, this emergency set could be started up to provide pilot lighting and a supply of power to the bridge for navigation. Normally the engine would be started by hand, but, if necessary, the Plessey arrangement could be used. With this device a special cartridge is inserted in a breech and fired into the cylinder of the starter. Firing of the cartridge causes an initial slow movement of the piston, which permits it to move forward and engage with the starter clutch on the crankshaft. The piston then travels further forward and spins the engine sufficiently fast to carry it over compression and start up. The engine usually makes four to six revolutions. This form of starting is handy for small units, as an immediate start is ensured, and it is simpler than installing compressed air or electric starting, where battery deterioration may occur due to standing unused for long periods.

The second example of the "DA" series of engines is a six-cylinder unit, developing 66 b.h.p. at 1250 r.p.m, which is exhibited as a complete power unit, the engine being complete with built-in radiator, fuel service tank and silencer. The unit is mounted on a rigid underbase and provided with a canopy covering, totally enclosing all parts of the engine with the exception of the overhung vee pulley, which is operated through a clutch drive and is available for connecting by belt to the driven machine. The unit, which is completely weatherproof, can be lifted by means of two shackles, transported and put down in any position required.

HYDRAULIC COUPLING AND ENGINEERING COMPANY, LTD.

Although comparatively little change has been made in the working circuit of the main types of fluid coupling built by the Hydraulic Coupling and Engineering Company, Ltd., Worton Road, Isleworth, Middlesex, a large number of new applications have been made in industry. The couplings on this firm's stand are therefore similar to those exhibited in 1947, but a collection of photographs is used to show some of the latest "Fluidrive" applications.

Certain improvements in detail have been made to the couplings, one being the fitting of a fusible plug in the impeller flange of all electrically driven fluid couplings of the traction type. This plug is intended to protect the motor in the event of the trip gear failing to operate after a sustained stall. In such a case the fusible plug melts when the temperature in the fluid coupling reaches a predetermined figure, and so empties the working circuit, thereby disconnecting the motor from the drive.

A new driving plate for transmitting the torque from the motor boss to the impeller, which has been developed, facilitates alignment in the field and provides an increased measure of flexibility.

A working model is intended to demonstrate what is now practicable with "Twin Fluidrive," a system of speed control giving a very wide range of regulation. It consists of a pair of standard squirrel-cage motors driving through fluid couplings of the traction type, coupled to the two input sides of a differential gear.

In it two motors A and B run at the same speed, but are of 10 h.p. and 5 h.p. respectively. The drive is taken from each motor through a fluid coupling and "Radicon" worm gear to the input shaft of the differential, the A and B worm gears being of 3·5 and 4·67 ratio respectively. A solenoid brake is fitted on the B drive so as to brake one side of the differential when the B motor is switched off. The output side of the differential in this particular example drives a sugar centrifugal which is loaded with lead to the equivalent of a full charge and operates over a speed range of 50 to 60 r.p.m. to 1100 r.p.m.

By means of reversing contactors the motors can be energised so as to give slow, medium and full speed to the centrifugal machine with smoothness and a measure of regenerative retardation down to slow speed. Furthermore, full torque with the load stalled or creeping can be sustained indefinitely, making this system of drive suitable for application to a.c. electric winches and other hoisting plant where stalling, creeping, medium and fast working speeds are required.

JOHN I. THORNYCROFT AND CO., LTD.

The exhibits on the stand of John I. Thornycroft and Co., Ltd., are designed to show the company's many and varied activities, both afloat and ashore. In addition to models of a typical water-tube boiler installation, a number of small marine diesel engines are exhibited, together with very fine models of a 4400-ton fast passenger and cargo vessel built for the Compagnie Générale Transatlantique, and an ocean-going tug.

Of particular interest is the firm's equipment for liquid fuel burning, and to demonstrate its application and method of operation an apparatus has been installed on a typical boiler furnace front.

Although most extensively used for marine boilers, many burners of similar design are in use on industrial boilers fired either with fuel oil or with creosote/pitch, the only special requirement with the latter being the provision of steam heating pipes in the supply tanks and pumping system in order to obtain sufficient fluidity for handling. By changing the size of atomiser parts the standard burner and air register has an output range from 150 lb to 1500 lb per hour.

When boilers are provided with mechanical draught the air quantity is controlled by the speed of fans. In natural-draught furnaces the amount of air entering is largely regulated by the temperature of the boiler flue gases, i.e., by the amount of fuel being burnt. Generally speaking, fuel outputs up to about 300 lb per hour can be burnt under natural draught, depending upon the height of stack, gas temperature and resistance. Above this output, the makers point out, some form of forced or assisted draught is necessary.

The large furnaces of water-tube boilers are usually fitted with a group of similar burner units arranged in such a manner as to concentrate the flames at a focal point near the furnace centre. The provision of a number of similar burner units per boiler enables quick power changes to be made

without changing burner sizes. In the small cylindrical furnaces of Lancashire, Scotch and other fire-tube boilers large changes in steam output are made by changing the size of sprayer tips, a simple operation which can be quickly effected.

The arrangement of the component parts of a burner can clearly be seen in the drawing Fig. 4, and the photograph reproduced in Fig. 5. The sprayer is mounted on a tripod carrier, which is attached by means of three long studs to the furnace front. This tripod can be adjusted along the studs to set the sprayer in a position to get the best operating conditions. A pair of high-grade moulded refractory bricks which form the furnace throat are held in position by a split steel key ring secured by bolts to the outside of the furnace. The material from which these throat units are made is capable of withstanding the high temperatures existing at this part of a furnace. The surfaces are particularly smooth and durable, and normally with the flame positioned correctly the amount of carbon deposited on the throat bricks is stated to be negligible.

The sprayer is connected to the fuel supply by a flexible pipe of adequate length to permit its correct adjustment in the carrier. Air is admitted into the unit through six shutters arranged around the body and so designed to produce a whirling stream of air. Efficient and complete mixing takes place when this stream of air meets the finely divided fuel spray. A single-hand lever is used to operate the air shutters so that simultaneous adjustment can be effected with one hand only. This is a point of particular importance in the case of emergency, when one hand is needed to shut off the fuel and the other the air supply.

When it is required to change a sprayer in the unit no fuel joints have to be broken and the amount of fuel contained in the burner body is very small, thus minimising drips and enabling clean handling.

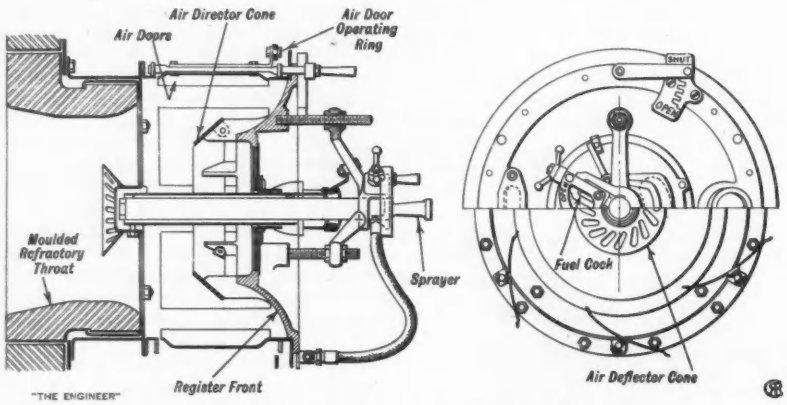


FIG. 4—ARRANGEMENT OF LIQUID FUEL BURNER—THORNYCROFT

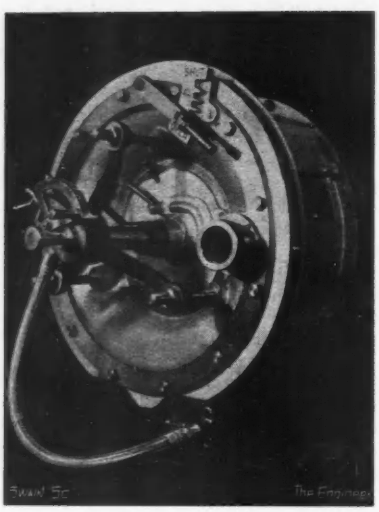


FIG. 5—LIQUID FUEL BURNER—THORNYCROFT

Typical of the marine diesel engines made by this company for powering small craft is the RTR/4 unit, illustrated in Fig. II in the Art Supplement. This engine has a bore of 3⅝in and a stroke of 4½in and develops 30 b.h.p. at 1750 r.p.m. Hand starting of this engine is fairly easy, but as the unit exhibited is intended for use on a ship's lifeboat, it is also fitted with means of electric starting. It has two dynamos, one for charging the starter battery and the other to provide current for a wireless installation and searchlight.

The cylinder block of this engine is a rigid iron casting, with renewable dry liners. Its forged steel crankshaft is mounted in five main bearings of the thin wall pre-finished precision type. The aluminium alloy pistons have three compression rings and a scraper ring, whilst the gudgeon pins are fully floating both in the pistons and small end bushes. A toroidal combustion chamber of patented design is formed in the crown of each piston.

Lubrication is by wet sump pressure feed, and a gear oil pump is driven through skew gears from the camshaft. A by-pass filter is fitted in the lubricating circuit and a water-jacketed oil cooler is incorporated in the delivery line between the oil pump and the engine.

The fuel injection equipment consists of a C.A.V. cam-operated plunger pump with an integral governor, working in conjunction with C.A.V. injectors and filters. Fuel is supplied by a feeder pump driven from the injector pump camshaft.

Cooling is direct by sea water, which is pumped through the engine waterways, reducing gearcase and oil cooler and finally injected into the exhaust system, thus providing an effective silencer.

A flange-mounted mechanically operated reverse gear is fitted to the engine, together with a heavy-duty water-cooled, 2–1 reducing gear. The operation of the reverse gear ahead is through a multi-plate clutch and astern by an epicyclic gear train and an external contracting band brake. A bearing is fitted in the reducing gear housing and carried on the output shaft to take the thrust from the propeller.

ARC MANUFACTURING COMPANY, LTD.

A portable argon-arc welding plant suitable for welding light alloys is one of the interesting exhibits shown by the Arc Manufacturing Company, Ltd., Goldhawk Road, London, W.12. The "Actarc" argon-arc welding plant, Mark II, which is illustrated in Fig. XVI in the Art Supplement, is a self-contained unit incorporating welding transformer, regulator, high-frequency ioniser, d.c. suppressor unit, power-factor correction condenser and control gear. No auxiliary plant is required apart from the argon cylinder, which supplies argon to the electrode holder.

Welding current is fed to the electrode from a welding transformer and regulator specially designed for long welding runs as distinct from intermittent work. The primary winding of the transformer has tappings suitable for connection to 380-V, 400-V, 420-V and 440-V, 50-c/s mains ; the secondary winding provides current at a maximum of 110V. Current variation is obtained by the combined effect of two regulator handwheels, giving infinitely variable control between 25A and 300A, the transformer being rated at 215A at 0·75 duty cycle and 300A at 0·5 duty cycle.

The high-frequency ioniser incorporated in the equipment is a spark oscillator having a specially designed air-cored transformer, with an output frequency of 3·5Mc/s. Its purpose is to operate momentarily on striking the arc with the object of correcting any tendency to instability during welding. A separate filter circuit of G.P.O. design is included, to reduce radio interference to a minimum. The d.c. suppressor unit is connected in series with the secondary circuit and is therefore capable of carrying the full welding current.

A main 400-V contactor, operated by the welder through a remote control switch, controls the supply to the set and isolates the transformer when not in use, thus reducing the charge for no-load losses.

Connections for gas and cooling water supplies are provided on the welding torch. A safety device in the cooling water circuit is interlocked with the main contactor to ensure that failure of the water supply will shut down the whole set, and that the set cannot be switched on before the water supply is turned on.

FIG. 6—"MEDIA" WELDING TRANSFORMER —ARC MANUFACTURING

One version of the argon arc equipment embodies automatic control for gas supplies so that the argon gas is turned off after welding. This provision allows a given period for the tungsten electrode to cool in an inert atmosphere.

A newcomer to the company's range of welding products is the "Media" welding

transformer—an equipment built to the requirements of B.S. 638 and having a rating of 200A to 300A. Stepless control of welding current from 20A to 300A is provided by a handwheel mounted on top of the casing, as illustrated herewith, and the actual welding current is shown on a large drum-type indicator which is clearly visible at a distance. Primary tappings are taken to a terminal board at the side of the transformer, conveniently accessible through a hinged panel on the side of the case. The welding leads are connected to the set by standard interlocking plugs and sockets.

The standard casing, which is coach finished in maroon with chromium-plated fittings, is large enough to accommodate a high-frequency ioniser unit and a built-in condenser for power factor improvement. The complete assembly is mounted on four rubber-tyred wheels and a conveniently placed handle makes steering simple.

Two new high-frequency units have been developed by the Arc Manufacturing Company for use in conjunction with their standard welding transformers—a combination that is specially useful for arc welding on non-ferrous metals. One of these high-frequency ionising units is a spark oscillator having finely tuned circuits giving a frequency closely controlled to 3·5 megacycles to reduce interference with radio communication circuits. This equipment, known as a "Polytrode," is a self-contained unit as illustrated below. It can be connected in series with any welding transformer, to superimpose a high-frequency high-voltage current on the welding arc. The "Polytrode" is

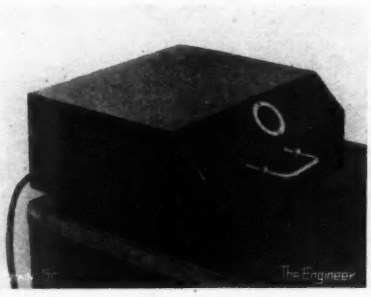


FIG. 7—HIGH-FREQUENCY IONISER—ARC MANUFACTURING

energised through a flexible lead which can be connected to any convenient 230-V or 400-V lighting or power point. Connections from the welding set are taken into the "Polytrode" via plug-and-socket connections, and the earth cable and electrode holder cables are similarly connected to the corresponding plug and socket on the opposite side of the machine. When the "Polytrode" is connected in series with the welding plant in this way welding can proceed whether the high-frequency generator is energised or switched off. Control of the high-frequency output is obtained by a switch on the side of the case or by a remote-control foot switch.

The second kind of high-frequency ioniser unit is a valve oscillator which can be accurately tuned, for use in all instances where interference with radio communications must be reduced below the limit that is practicable with the spark-gap oscillator.

JOHN FOWLER AND CO. (LEEDS), LTD.

A new diesel locomotive developed by John Fowler and Co. (Leeds), Ltd., has been specially designed for arduous shunting duties. It is made in two sizes of 80 b.h.p. and 150 b.h.p., and an engine of the larger size is exhibited at Olympia.

This locomotive, a general arrangement drawing of which is shown in Fig. 8, has a four-stroke, six-cylinder McLaren M.R.6 engine with a traction rating of 150 b.h.p. at 1000 r.p.m. It weighs 28 tons in full working order and has four speeds in each direction.

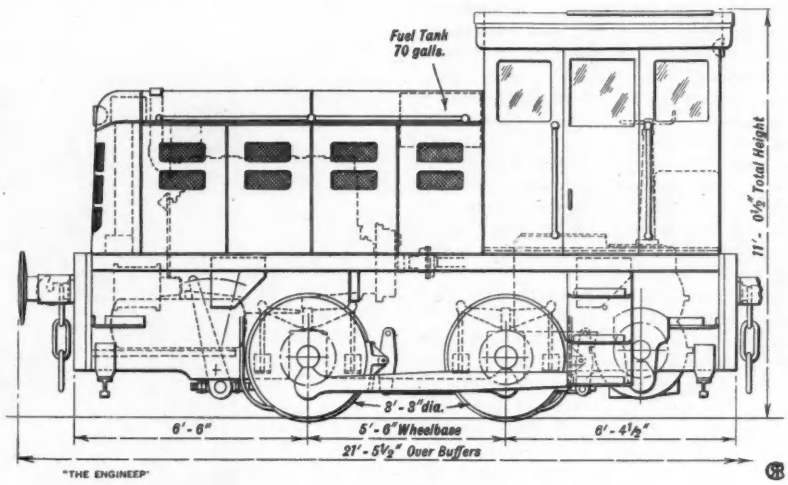


FIG. 8—150 B.H.P. SHUNTING LOCOMOTIVE—FOWLER

These speeds, with the respective tractive effort in brackets, are as follows:—3 m.p.h. (15,000 lb), 4·65 m.p.h. (9675 lb), 7·85 m.p.h. (5730 lb) and 10 m.p.h. (4500 lb).

Power is transmitted from the engine to the gearbox by means of a spring-loaded dry plate clutch, the bonded asbestos frictional surfaces of which are large and lightly loaded to ensure long life and satisfactory service. The clutch is power operated by means of levers actuated from a compressed air cylinder, the pressure of air in this cylinder being varied by means of a self-lapping air valve operated by lightly loaded foot pedals. This arrangement enables the driver to exercise variable control of the clutch operation with a minimum of manual effort.

A synchromesh gearbox in the main frame has gears of the constant-mesh type, changes being effected by synchronising cones and internal tooth clutches. A reverse gear of the bevel wheel type is incorporated in the box. Final drive is by means of large spur wheels to a jack shaft, which drives the road wheels through the connecting-rods. With the exception of the jack shaft, which is mounted in large gunmetal bushes, all the shafts are mounted on ball or roller bearings. The gears are of high-tensile alloy steel with machine-cut case-hardened teeth. The gearbox is totally enclosed and all the transmission runs in oil.

RUSSELL NEWBERY AND CO., LTD.

A new engine on the stand of Russell Newbery and Co., Ltd., of Essex Works, Dagenham, is the six-cylinder, exhaust-turbo-charged "EM" marine engine, a three-quarter view of which looking on the turbo-blower end is reproduced in Fig. X in the Art Supplement. The designed output of this engine is 145 b.h.p. when running at 1000 r.p.m. under pressure-charged conditions. The cylinders have a bore of 5½in and a stroke of 7¼in. The turbo-blower was supplied by the British Brown-Boveri Company, Ltd., and we are informed that its adoption has increased the power output of the engine by as much as 45 per cent. On the stand the unit is displayed as a running exhibit, and is shown driving a bronze propeller through a standard stern tube, the necessary speed reduction being obtained by a direct-coupled "RN" fluid-operated 2 : 1 reverse reduction gear. A remote-controlled telegraph head for the distant control of engine speed is also fitted.

While the basic parts of the engine follow the firm's standard marine practice, the design has been cleaned up to give easier access to the crankcase, which has been attained by fitting the auxiliary equipment in the way of the timing gear casing. Again better access to the fuel-injection nozzles has been provided by a new arrangement of exhaust manifolds. Other improvements include the fitting of a duplex lubricating oil filter, which enables one element to be cleaned or replaced while the engine is running. By fitting a reducing valve in the head casting of the

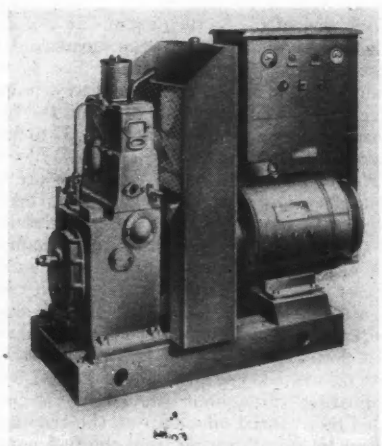


FIG. 9—6-KW ALTERNATOR SET—RUSSELL NEWBERY

lubricating oil filter, low-pressure oil lubrication has been applied to the rocker gear operating the inlet and exhaust valves. A twin lubricating oil cooler, which is mounted near the reverse gear, gives an advantageous oil pipe arrangement.

The "D" type engine made by the firm is shown in various forms. We illustrate in Fig. 9 the 6-kW fully automatic alternator generating set incorporating an "RN" 12 b.h.p., "DXI" single-cylinder engine with a cylinder bore of 4⅛in and a stroke of 6in driving the alternator at 1500 r.p.m. The engine, it will be seen, is complete with its radiator, control panel, and fuel tank, and

forms a completely self-contained generator unit mounted on a fabricated steel underbase.

A similar twin-cylinder "RN" engine of the "D" series is shown as a typical marine auxiliary set, driving a 5-kW d.c. generator through a flexible coupling, and an air compressor and self-priming centrifugal pump through a clutch. The engine develops 18 b.h.p. at 1000 r.p.m. The same engine is shown driving a fire-fighting auxiliary set for use on ship-board, and is in accordance with the Board of Trade requirements under the Merchant Shipping (Fire Appliances) Rules. The engine has a designed output of 21 b.h.p. at 1250 r.p.m., and drives the pump through a flexible coupling, the whole unit being mounted on a fabricated underbase of steel. A header tank furnishes a sufficient head of water in the engine during the initial starting period, and as soon as the main pump starts up water for the cooling of the engine is bled off.

Among the industrial engines is a standard three-cylinder "D" engine designed to develop 31 b.h.p. when running at a speed of 1200 r.p.m. with a standard power take-off and clutch mechanism for general industrial service. The engine is contained in a casing and is complete with its radiator, fuel tank and cowl. A standard four-cylinder "D" engine arranged for industrial work is also on view and it develops 36 b.h.p. at 1000 r.p.m. A sectioned model of the single-cylinder "DX" engine shows the main constructional details of the "RN" engine and the combustion chamber.

HENRY MEADOWS, LTD.

A number of engines for marine and industrial use are shown by Henry Meadows, Ltd. of Wolverhampton, and amongst the diesel units is the "Frobisher" marine engine, illustrated in Fig. 10. This six-cylinder, direct-injection, four-stroke engine has a continuous cruising rating of 95 b.h.p. at 1700 r.p.m. with a maximum emergency brake horsepower of 130 at 1900 r.p.m. It is available with a range of reduction gears and is made for installation on either fast hard-chine craft or those having a heavy round bilge. Under full load at 1700 r.p.m. the fuel consumption is stated to be 0·37 lb per brake horsepower per hour.

The cylinder block and crankcase are of monobloc construction, the cylinders being fitted with renewable dry liners and having detachable heads formed in two interchangeable units. The overhead valves are operated by cast iron tappets through short push rods by a seven-bearing camshaft. Interchangeable twin-inlet manifolds, each covering three inlet ports, are each provided with a heavy-duty oil-wetted type air cleaner. Forced-feed lubrication throughout the engine is provided by a geared oil pump at the rear and driven by spiral gearing from the fuel pump drive. A completely enclosed fresh water cooling system incorporates a large-capacity heat exchanger at the forward end of the engine. This heat exchanger is double banked for the purpose of fresh water and lubricating oil cooling. The tubes in the heat exchanger through which the cooling sea water is passed are fed by a sea water pump, which draws water through the reduction gear casing. After passing through the heat exchanger the sea water is pumped through the exhaust manifold before being discharged overboard.

A hand lever-operated bevel reverse gear is fitted with a multi-plate clutch, the band brake used for reverse operation being lubricated by a plunger pump driven from the main shaft. Helical reduction gears with ratios of 1·5 : 1, 2 : 1 or 3 : 1 can be fitted to the engine according to the class of craft it is used on. Accessories can be fitted on either side of the engine and the direction of rotation is optional, so that the unit is well suited for twin-screw installations.

Among the self-contained industrial power plants is one of the firm's "EL/AV" engines, which is arranged for petrol/natural gas operation and has been developed for use in oilfields. This set is complete in all respects and includes clutch, outboard bearing and tailshaft, special automatic devices being incorporated to shut the engine down in case of low oil pressure or water level. The continuous power available is 26/42 b.h.p. at 1000/1800 r.p.m. on petrol and 21/34 b.h.p. on natural gas. It can also be operated on paraffin, the power developed being the same as with natural gas.

This four-cylinder engine, illustrated in Fig. XIV in the Art Supplement, has a bore of 95mm with a stroke of 130mm. The crankcase is extended to incorporate the flywheel housing and carries the high-tensile steel crankshaft on three bronze-backed white metal-lined bearings of large diameter. The pump of the forced feed lubrication system is fed from the sump and oil is pumped under pressure into a junction box on the offside of the cylinder block. From this box the oil is led back through copper pipes direct to each of the crankshaft main bearings and along passages drilled in the crankshaft to the connecting-rod big end bearings. A branch pipe from a filter feed pipe carries oil through the head to the rocker shaft to lubricate the rocker bushes and push rods through small holes. The centre camshaft bearing is lubricated by the flow of oil through a bleed hole in the rocker shaft, which passes through a cored passage in the cylinder head and block. A jet of oil lubricates the timing gears, governor and idler gear and the front camshaft bearing, the pistons, gudgeon pins and tappets being splash lubricated.

The engine is fitted with a Mangoletzi carburetter, designed for natural gas operation and incorporating a special valve which can be brought into use when running on petrol. The change over from gas to petrol or vice versa can be quickly made without stopping the engine.

One of the firm's six-cylinder, 10·35-litre diesel engines is incorporated in a 50/60-kW generating set with a 400/230-V, three-phase, 50-cycle, 0·8 factor supply. This generating set is completely enclosed and self-contained. It is fitted with 24-V electric starting, tropical radiator, fuel tank and silencer, all of which are integral with the plant.

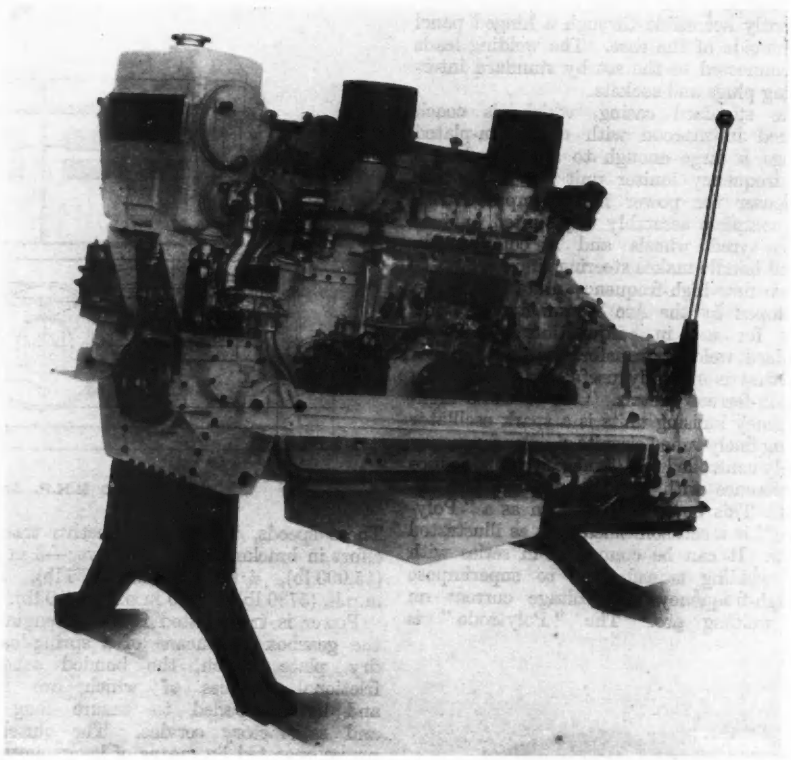


FIG. 10—95 B.H.P. "FROBISHER" MARINE OIL ENGINE—MEADOWS

LAURENCE SCOTT AND ELECTROMOTORS, LTD.

Among the winches exhibited by Laurence Scott and Electromotors, Ltd., Norwich, is a new product, known as the Scott "Convertor" winch, which has been designed for service on ships having a.c. supplies for auxiliary drives. The equipment incorporates a motor-generator set to supply the d.c. winch motor. This arrangement gives the flexible performance which is characteristic of the Ward-Leonard control system. The winch is arranged for remote control with dynamic braking. In general mechanical construction the "Convertor" winch resembles the other Scott cargo winches, and it embodies silent gearing and weatherproof enclosure designed for ease of access for inspection and maintenance.

The general arrangement of the "Convertor" winch is shown in the photograph reproduced in Fig. XIII in the accompanying Art Supplement. It will be seen that the winch motor is mounted on the left of the bed-plate, the magnetic disc brake being fitted on a shaft extension at the commutator end of the motor. The cast bed-plate houses the motor generator set and control gear. A removable cover immediately below the magnetic brake on the driving motor gives access to the d.c. end of the motor-generator set, which comprises d.c. generator, induction

motor, fan and exciter mounted in tandem as a single assembly. A separate compartment with its own hinged access cover to the left of the motor-generator compartment houses the contactor gear. In this form the "Convertor" winch occupies the same deck space as the equivalent d.c. winch, and the overall height is only increased by 10in. If desired, however, the motor-generator set can be accommodated separately in a deck house.

Remote control is carried out from a small pillar which can be mounted in any convenient position, such as one which gives the winchman a clear view into the hold. The pillar carries the master control handle and an emergency "stop" push-button, another "stop" push-button being fitted on the winch itself. If desired the control pillars for a pair of winches can be mounted together.

The specified duty of the "Convertor" winch is 3 tons (full load) at 100ft per minute, 2 tons at 150ft per minute, and light running at 450ft per minute. High starting torque can be exerted without damage and the Ward-Leonard arrangement provides constant horsepower throughout the working range.

Regenerative braking on four notches provides controlled lowering, and creeping speed can be obtained with all loads when lowering. Apart from the magnetic disc brake, the d.c. motor is fitted with a centrifugal brake on a shaft extension at the driving end.

Another exhibit on the same stand demonstrates the application of a "N-S" variable-speed motor to the drive of a Richards boring mill.

The motor is of 37·5/12·5 h.p., its speed is infinitely variable between 1500 and 500 r.p.m., and it is arranged for dynamic braking. The mill itself has three sets of mechanical gearing.

Variation of motor speed is achieved by means of a remote-controlled induction regulator which, together with all the necessary starting and protecting apparatus (and in this case also the control gear for the mill feed motor) is housed in a cubicle. The motor control is arranged to give either constant cutting speed at any diameter of cut, or any constant motor speed, in both cases the speed being adjustable within the designed range.

There is a pendant push-button station with push-buttons for "start," "stop," "inch forward" and "inch reverse," and another for the feed motor with "forward" and "reverse" buttons. In addition, there is a speed control box fitted with a tachometer, selector, and control dials for cutting speed and table speed.

The selector has two positions, "constant motor speed" and "constant cutting speed." In the former position, movement of the table speed control dial brings the motor to the selected speed, to which it will return after every stop and restart; in the second position the motor speed is automatically adjusted to maintain constant cutting speed with varying diameter of cut. The actual selection of the desired speed is made on the appropriate control dial, either before starting or while the motor is running.

The table speed control dial is calibrated in revolutions per minute on three scales corresponding to the three sets of mechanical gearing. Movement of the dial alters the setting of a potentiometer in the control circuit, which effects correct adjustment of the induction regulator position. The "constant cutting speed" control dial is also calibrated on three scales, in feet per minute. With this control in use an additional potentiometer, mechanically coupled to the tool traverse motion, adjusts the motor speed so as to maintain constant cutting speed as the tool traverses.

DAVEY, PAXMAN AND CO., LTD.

An outstanding oil engine exhibit to be found on the stand of Davey, Paxman and Co., Ltd., of Standard Ironworks, Colchester, is the largest unit in that firm's "R.P.H." series—a sixteen-cylinder, four-stroke, pressure-charged engine with a designed output of 667 b.h.p. at a speed of 1000 r.p.m. The cylinders of this engine have a bore of 7in and a stroke of 7¾in. In general construction the unit follows closely the basic design adopted for the six and twelve-cylinder models in this series. Due, however, to the increased number of cylinders and considerations of size, some details differ, but interchangeability over the whole series has been maintained, as far as the majority of working parts are concerned. In this particular engine, however, a larger diameter crankshaft is fitted to meet the increased power developed. Pressure charging is effected by single-stage centrifugal blowers which are driven by exhaust gas turbines.

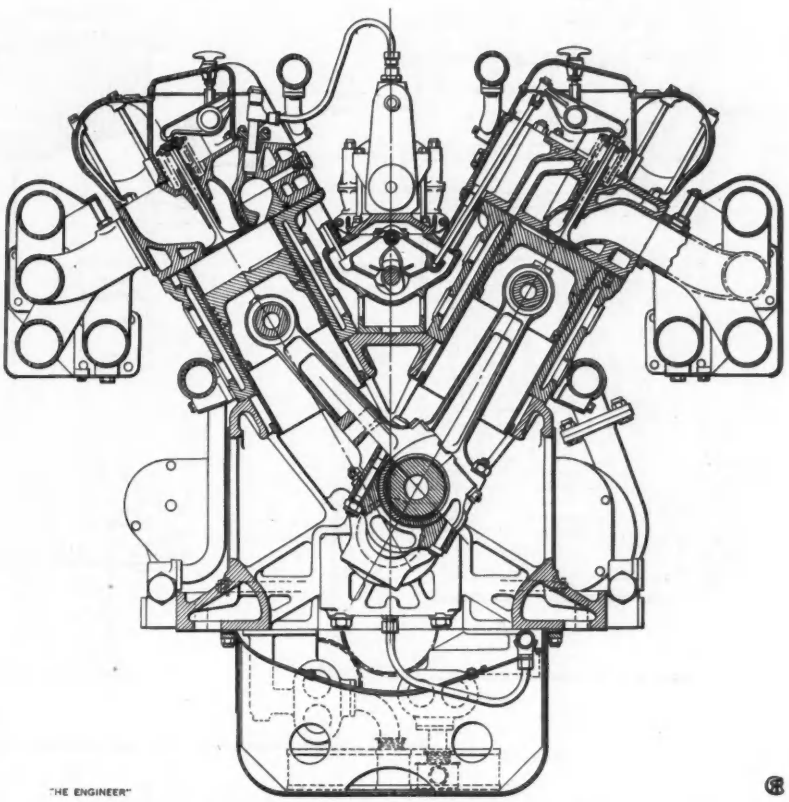


FIG. 11—ARRANGEMENT OF PRESSURE-CHARGED ENGINE—PAXMAN

The general design and arrangement of the engine is shown by the accompanying drawing (Fig. 11). The fuel pumps are placed centrally and are mounted directly over the camshaft, which also operates the push rods for the valve gear through rocker levers. As will be seen the exhaust system is conveniently arranged outside each bank of cylinders, the exhaust pipes being accommodated in dry-type lagged manifolds, as distinct from the arrangement between the banks of the cylinders which is adopted in the case of the other "R.P.H" models.

The design of this series of engine can be conveniently studied in a full-scale sectional model of the twelve-cylinder "R.P.H" engine, which has a designed output of 500 b.h.p. at 1250 r.p.m. Another engine in this series is the six-cylinder in-line model with an output of 200 b.h.p. at 1000 r.p.m. All these engines are built up from a number of self-contained assemblies, which by their light and compact form assure speed and ease in routine maintenance operations. During the past two years the "12 R.P.H" engine has been widely used in this country and overseas for diesel-alternator plants and for oil-well drilling operations.

Another engine which is displayed on the stand is the six-cylinder, four-stroke, marine propulsion engine of the "R.W." series, which embraces four, five and six-cylinder models. This unit has cylinders with a bore of 5¼in and a stroke of 7in, and is shown as a complete marine propulsion engine with a rating of 112 b.h.p. at 1000 r.p.m. The engine is shown with a 2 : 1 oil-operated "S.L.M." reverse reduction gear and a Brunton stern tube and propeller. In addition to its use as a marine propulsion or marine auxiliary engine, it has been successfully used in rail traction and industrial installations. A 140 b.h.p. engine of the "R.W." series is shown in Fig. IX in the Art Supplement.

Another engine shown is the four-cylinder, "R.P.L." vertical four-stroke engine, which has a designed output of 243 b.h.p. at 650 r.p.m. It is representative of a series of vertical and vee units, built for industrial, marine and rail traction duties and has been developed from the original Paxman totally enclosed medium-speed engine. It now incorporates the Ricardo system of combustion and all working parts are pressure lubricated. Among recent installations using this particular form of prime mover we may mention the two dredgers built for the Mersey Docks and Harbour Board, the "Mersey No. 26" and the "Mersey No. 27," which are twin-screw electrically

propelled ships with twelve-cylinder "R.P.L." vee engines.

The range of Paxman boilers includes horizontal and vertical boilers of the "Economic," "Ultranomic" and all-steel

cylinders have water jackets of ample size to provide efficient cooling. Cast iron pistons are fitted and high-tensile carbon steel piston-rods have solid forged ends machined to receive cast iron slippers and a white-metal-

under pressure by an oil pump driven from the crankshaft, and oil is fed to the cylinders and stuffing boxes by a sight feed lubricator, also driven from the crankshaft. The plunger pump and the lubricator are built

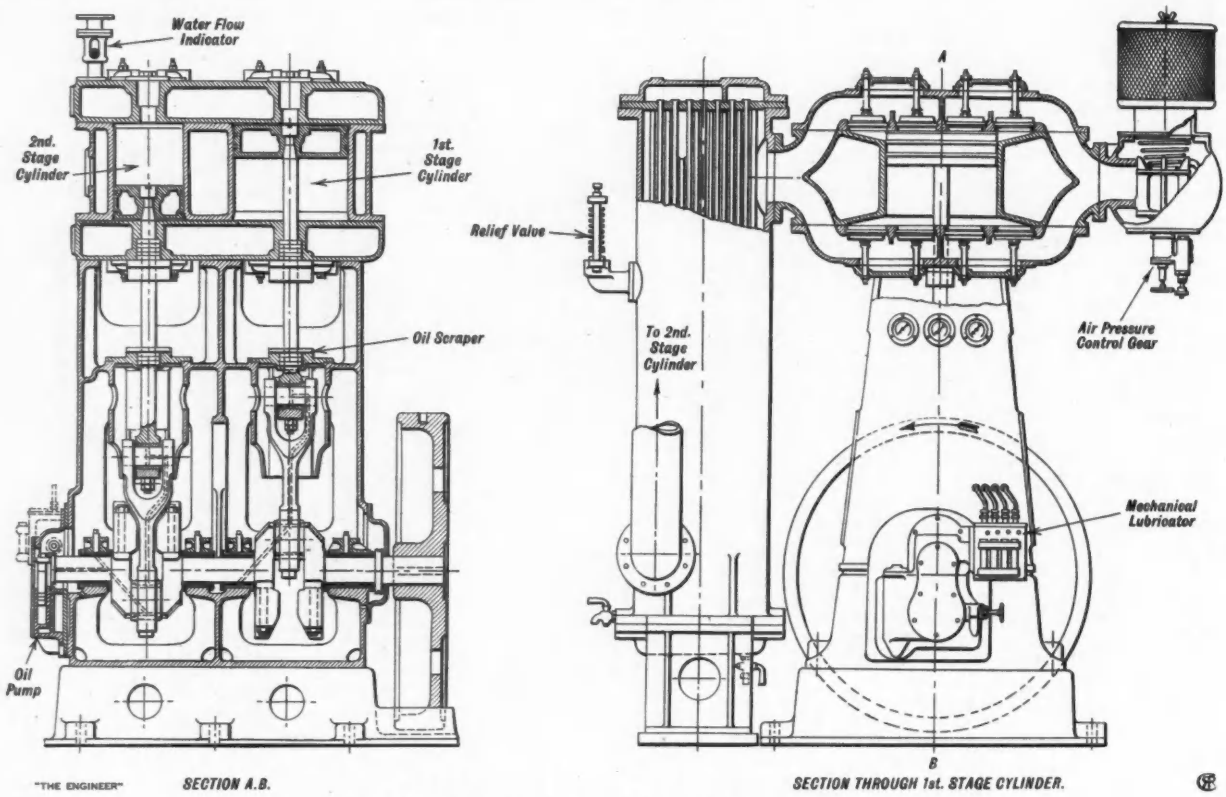


FIG. 12—ARRANGEMENT OF AIR COMPRESSOR—MACLELLAN

sectional patterns, for heating, power generation and industrial process work, and is represented by a scale model of the firm's "Ultranomic" double-pass boiler.

Davey, Paxman and Co., Ltd., also manufacture rotary vacuum filters for chemical and industrial processes and in this connection it is exhibiting the smallest filter in the range, which covers units with filter areas from 10 square feet to 700 square feet.

ALLEY AND MACLELLAN, LTD.

From its wide range of air compressors, Alley and MacLellan, Ltd., of Polmadie, Glasgow, S.2, has selected for exhibition one of its series "45 B 8" machines with a capacity of 600 cubic feet per minute at a working pressure of 100 lb per square inch. This machine is direct-coupled to a 120 h.p. auto-synchronous electric motor. It is of the two stage, two-crank, double-acting, crosshead type with the intercooler incorporated in the cylinder casting.

This machine is illustrated in Fig. XIX in our Art Supplement, and its general arrangement is shown in the drawing reproduced in Fig. 12. The machine in the drawing is of similar design to that in the illustration, but, being of larger capacity, it has a separate aftercooler. In order to eliminate piston side thrust on the cylinder wall and prevent oil leakage from the crankcase to the air supply, this crosshead type of machine is built with its cylinders completely isolated from the crankcase.

Crankcases for these machines are of cast iron or fabricated steel, and are built integral with the crosshead guides. Cast iron cylinders and distance pieces are accurately machined to line up with the crankcase, and the lined cast steel small end bush. The connecting rods of forged steel have hardened and ground pins shrunk into them for working in the small end bush, and are fitted with white-metal-lined cast iron big ends. Automatic disc type suction and discharge valves are fitted in which the working plate of thin and light steel is held against the malleable iron valve seat by springs. Each valve chamber is surrounded by a cooling water jacket.

All bearings in the machine are lubricated as a single compact unit at one end of the crankcase and are readily accessible for inspection and maintenance purposes.

In addition to this machine a two-stage compressor of the differential piston type and a small compressor with a direct-on-steam cylinder drive are shown, together with a range of accessories and valves.

SHARPLES CENTRIFUGES, LTD.

A portable oil purifier designed to give a relatively high output with a small size of

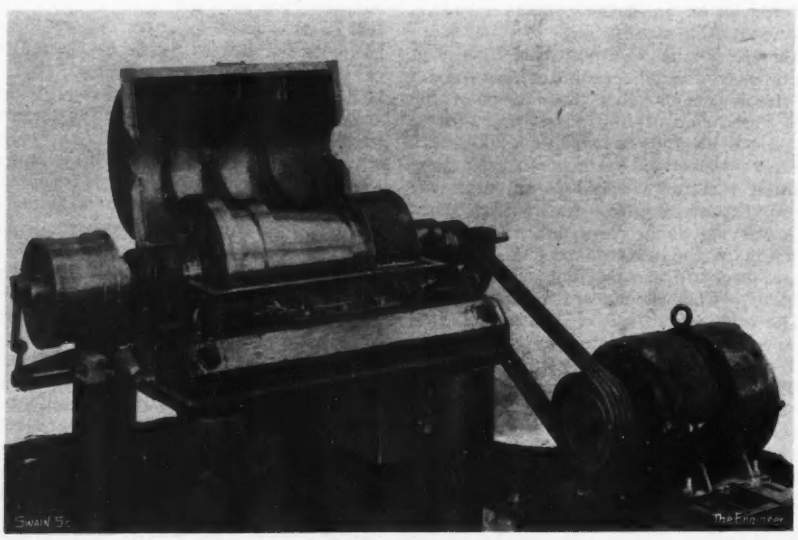


FIG. 13—"SUPER-D-CANTER"—SHARPLES

centrifuge is shown on the stand of Sharples Centrifuges, Ltd., Woodchester, Stroud, Glos. This equipment, to be seen in Fig. 16, incorporates one of the firm's "Vaportite" centrifuges, suction and discharge pumps and the dirty-oil pump *A* which draws oil through the electric heater *B* to the centrifuge *C*. A control valve *D* in the line regulates the quantity of oil delivered to the centrifuge. There is also provided in the line between the does not require heating before being centrifuged the heater can be by-passed by the setting of three valves.

The bowl supplied with the machine is of the dual-purpose type and may be used as a

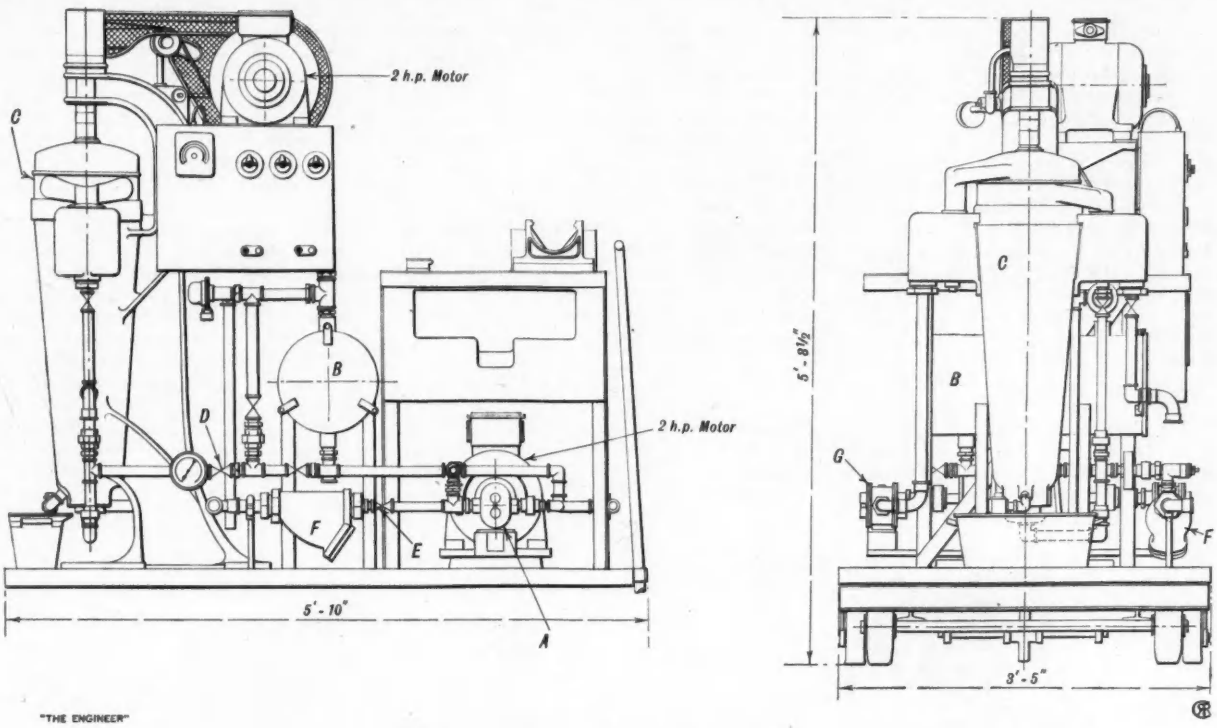


FIG. 14—ARRANGEMENT OF OIL PURIFIER—SHARPLES

an electric oil heater, all mounted on a wheeled truck complete with pipework. Its functions are controlled by an automatic timer unit, operating through solenoid relays, which control air-operated valves, no operating labour being necessary with the plant.

The arrangement of the unit is shown in the drawing reproduced in Fig. 14, showing inlet hose and the control valve a suction valve *E* and a strainer *F*. Purified oil from the centrifuge is delivered to a clean oil pump *G* and discharged through a hose.

The electric heater is provided with a drain cock and a locked safety valve, which is adjusted to prevent excessive pressure building up in the heater in the event of the valves being shut and the power left on. If the oil clarifier or a separator. If there is but little water in the oil, blank discharge screws can be screwed into the bowl and then only oil will be discharged. In this arrangement any water or impurities remain in the bowl until it is shut down for cleaning and the oil discharge is from the upper cover. When there is a considerable amount of water in the oil the bowl can be used as a separator by replacement of the clarifier blank screws with discharge screws. In this case oil is discharged from the upper cover of the unit and water from the lower cover.

On the control panel are mounted the centrifuge starter, the pump starter, three heater switches and a thermostatic indicating controller with which the oil can be maintained at any desired temperature within close limits.

A new solid basket centrifugal has been introduced by this firm for handling continuously any suspension of fine crystals or amorphous solids in a liquid. This unit, known as the "Super-D-Canter," can be seen with its upper cover swung back in Fig. 13. A vee-belt driven horizontal shaft carries a tapered basket, within which is mounted a scroll-shaped plough. This plough is arranged to rotate at a slightly slower speed than the basket. The liquid from which the suspensions are to be removed is fed into the unit at a point about midway in the basket. Clarified liquid is discharged over a series of weir plates in the larger end cover of the basket. The separated solid matter is moved forward by the plough to the smaller end of the basket, where it is discharged through slots in the basket periphery. The operation of the unit is continuous and automatic, and once the initial adjustments have been made no further control is required. This machine can be readily adjusted for use as a clarifier, a dehydrator or a classifier.

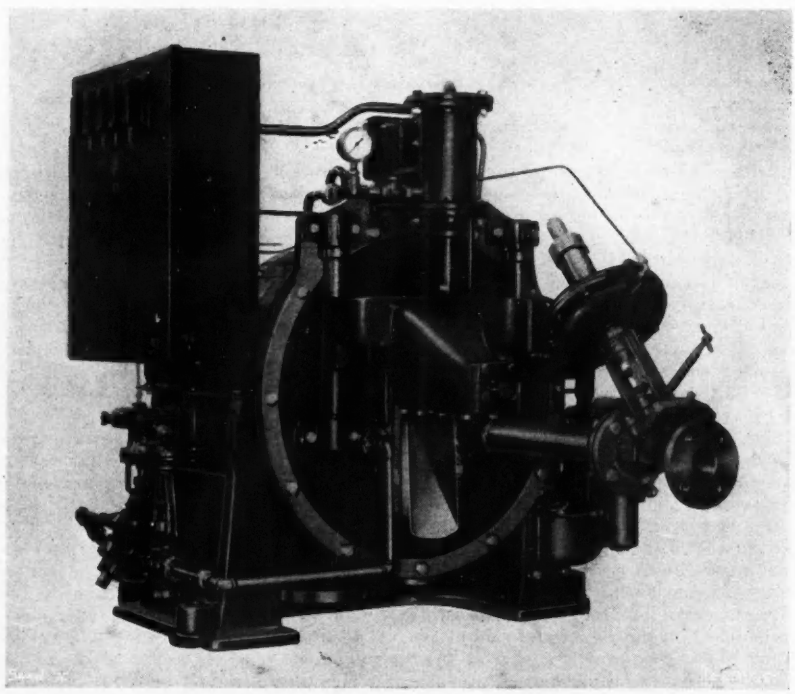


FIG. 15—"SUPER-D-HYDRATOR"—SHARPLES

The Sharples "Super-D-Hydrator," shown in Fig. 15, is a completely automatic centrifuge for the recovery and dehydration of crystals. In its operation a small batch of crystals is removed from a slurry, rinsed to a desired purity, spun at a high centrifugal force to near dryness and discharged. The various cycles of loading, rinsing and drying can be varied independently of each other and any portion of a cycle can be adjusted whilst the machine is in operation to give the desired purity and dryness of product.

The machine is a horizontal-axis, perforated-basket centrifuge and is available in two sizes, one with a bowl having an inside diameter of 20in and one with a bowl of 27in. A 2in deep layer of crystals is automatically maintained in the 20in bowl and a 3in layer in the 27in bowl machine. A unit discharge of 1 cubic foot of crystals per cycle is obtainable with the 20in machine, and 2 cubic feet from the 27in machine. In the smaller machine bowl speeds may be as high as 2100 r.p.m. and in the larger machine 1800 r.p.m., the respective drives being a 20 h.p. and a 40 h.p. electric motor.

Within the perforated bowl of this machine a fine-mesh screen is interposed between two coarse endless 8 by 30 mesh screens. An unloading knife in the bowl is arranged to rise and cut the crystals away from the innermost screen and leave on it a thin residual layer. Directly under the knife is a discharge chute, through which the crystals are removed from the machine. The knife is moved into and away from the deposit of crystals on the screens by means of a piston actuated by a hydraulic cylinder.

In operation the slurry is admitted to the centre of the bowl through a diaphragm-operated valve and a leveller within the bowl rides on the surface of the crystal layer as it is deposited and maintains balance. The mother liquor thrown free from the crystals through the mesh and perforated bowl by the action of centrifugal force is led out at the bottom of the casing of the machine. When the crystal layer on the sides of the bowl has reached a predetermined thickness the feed valve of the machine is closed by the leveller.

After the crystal bed has been formed in the bowl, rinse liquor is spread in a thin layer over its face to cause efficient displacement combined with a scouring action. The crystals then of desired purity, are spun to the desired moisture content, after which the rising knife cuts into the layer and the crystals are discharged. A very thin layer of crystals is retained on the filter screen to provide a filter medium for the next deposit. With some forms of material it is necessary to perforate this residual layer of crystals in order to provide free drainage for the next feed cycle. This perforation is effected by the introduction of a screen rinse cycle of water or steam, which may be varied to produce optimum conditions for free drainage and yet minimize crystal loss in the mother liquor.

As already stated, the cycles of feed, rinse, drying, discharge and screen rinse are consecutive and automatic, and they can be varied independently without necessity for stopping the unit. Two or more rinses are available in the event of it being desirable to rinse the cake with various liquors, such as a neutralising agent followed by water.

D. Napier and Son, Ltd.

Turbo-blowers manufactured by D. Napier and Son, Ltd., of Acton, London, W.3, are designed to increase the power output of diesel engines by some 50 per cent by pressure charging at a boost pressure of 5 lb per square inch. These boosters can be run continuously with a delivery pressure of up to 7½ lb per square inch with a correspondingly greater increase in power output, if the engine is capable of withstanding the higher loadings imposed, and up to 8½ lb per square inch for periods not exceeding one hour.

The blowers are made in four standard sizes, for engines with naturally aspirated ratings between 180 b.h.p. and 1400 b.h.p., there being alternative diffusers and a wide range of turbine wheels which are interchangeable between standard castings to enable optimum matching of blowers with particular engines. The photograph in Fig. 17 above shows the blower in section and from it the arrangement of the various components can clearly be seen. We also reproduce a photograph of the blower in Fig. XII in the accompanying Art Supplement.

In operation exhaust gases from the engine enter a turbine inlet casing of heat-resisting "Meehanite" on the right-hand side of the blower. These gases are directed by a series of nozzle vanes on to the blades of a turbine wheel in the adjoining turbine outlet casing which forms the support of the whole unit. After passing the turbine wheel the gases leave the casing through a large rectangular aperture. A centrifugal impeller at the opposite end of the turbine shaft draws in air and compresses it, the compressed air passing out of the unit by way of a vaned diffuser and a delivery volute in the compressor outlet casing.

The turbine casings are water cooled and an internal tapping from the delivery volute in the compressor outlet casing provides air for cooling the front face of the turbine disc. A designed leakage from a labyrinth type air seal machined on the rear face of the air impeller cools the rotor shaft and the rear face of the turbine disc.

The rotor shaft is carried in two resiliently mounted high-speed bearings, one in an aluminium-bronze housing at the compressor end and the other in a mild steel housing at the turbine end. The bearing at the compressor end locates the shaft and takes the axial thrust, whilst the bearing at the opposite end is arranged to move longitudinally to permit the axial growth of the unit due to thermal expansion. Each bearing is lubricated by an oil pump mounted outboard on the shaft at that end. Air-pressurised oil seals fed by air tapped from the pressure volute prevent oil leaking from the bearings into the casings.

Alternative turbine inlet casings with two, three or four gas entries are available to suit different types of engines, and two types of compressor inlet are available. One compressor inlet combines an air filter and silencer, and the other has a rectangular flange, to which ducting communicating with outside air can be attached. Each of the four main casings of the unit—the turbine inlet, turbine outlet, compressor inlet and compressor outlet—can be assembled in any of twelve circumferential positions. With this arrangement each casing can be rotated through 360 deg. in increments of 30 deg. and bolted to its mate at any chosen stage to suit the installation.

Broom and Wade, Ltd.

A new portable petrol driven air compressor, shown for the first time by Broom and Wade, Ltd., High Wycombe, is generally similar to the company's well-known sleeve-valve units.

This new compressor, a photograph of which is reproduced in Fig. IV in the accompanying Art Supplement, has an actual

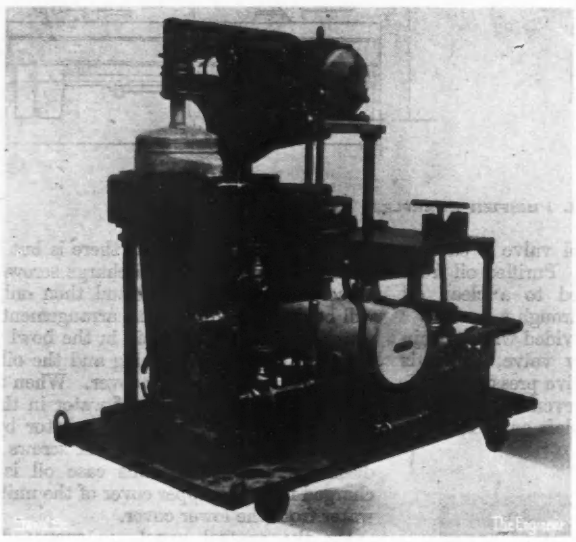


Fig. 16—Portable Oil Purifier—Sharples

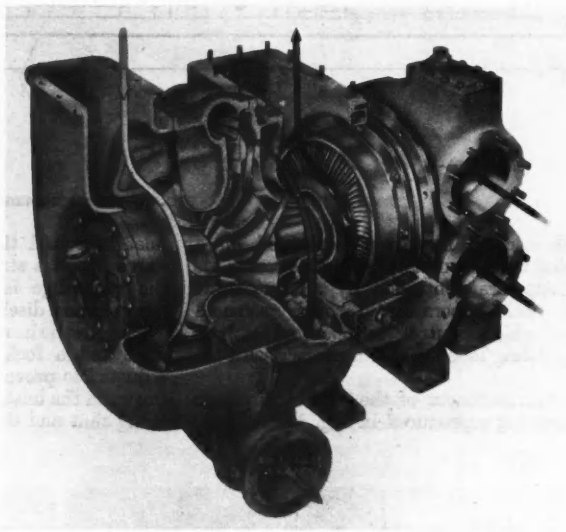


Fig. 17—Arrangement of Turbo Blower—Napier

delivered capacity of 60 cubic feet of free air per minute at 100 lb per square inch. Its two cylinders each have a bore of 4⅜in by a stroke of 3in, the piston displacement being 78 cubic feet per minute at 1500 r.p.m. The compressor is driven through an automatic centrifugal clutch by an Austin "Newage," four-cylinder, 22½ h.p. petrol engine. It is fitted with an automatic unloader, which in addition to unloading the compressor when the desired pressure in the receiver is reached, reduces the engine speed by operating the throttle control. A time lag device is incorporated, which automatically allows the engine to attain full working speed before the compressor picks up its load, when the air receiver pressure has dropped by a predetermined amount. In this new machine the sump is detachable and the caps of the two main bearings are underslung, the cylinders and top half crankcase being cast in one piece.

The equipment shown in operation on the stand includes one of the company's self-contained electrically driven air compressor sets mounted on a fabricated steel base with a horizontal air receiver mounted over the motor. This two-cylinder machine runs at 550 r.p.m. and delivers 60 cubic feet of free air per minute at 100 lb per square inch.

Also to be seen upon this stand is one of the firm's new rotary immersion type vibrators, a compact little tool with a head just over 1ft 9in long and 2½in diameter, designed to impart 7000 vibrations per minute. With its standard 4ft 3in length of air hose it weighs about 18½ lb and consumes 15 cubic feet of air per minute with a working pressure of 80 lb per square inch. The rotor of the air motor and the unbalanced rotating weight are carried in ball and roller bearings and are totally enclosed to prevent the ingress of moisture or dirt. Effective lubrication to the rotating parts is provided by one of the maker's "Ayrlyne" lubricators fitted at the end of the hose.

RUSTON AND HORNSBY, LTD.

Considerable interest will be taken in the exhibit of Ruston and Hornsby, Ltd., of Lincoln, for in addition to a representative display of oil engines for marine and industrial uses, the firm is showing for the first time a scale model of its new gas turbine. The first of these turbines with an output of 1070 b.h.p., has now been put to work in the Lincoln power-house, driving an alternator of 750kW output, supplying base load for the works. A view of the model is reproduced in Fig. 18 herewith. A full description of this unit will be found in our issue of August 19th.

The turbine consists essentially of a thirteen-stage axial-flow compressor delivering air through a contra-flow tubular heat exchanger to twin combustion chambers. The two-stage turbine, which drives the compressor, gives up its full power for that purpose, and the exhaust from that turbine passes through a two-stage power turbine which drives the alternator with its exciter and pilot exciter through double helical epicyclic 4 : 1 reduction gearing. The exhaust from the power turbine is then ducted back through the heat exchanger to the atmosphere. The set is started up by means of a 15 b.h.p., motor.

With a maximum gas temperature of 1340 deg. Fah. a compression ratio of 4 : 1 and heat exchanger of 75 per cent effectiveness the full-load efficiency at the output shaft is 24 per cent, while at 40 per cent load it is 17½ per cent. The neat arrangement of the various parts of the set is clearly illustrated in the engraving.

Another new exhibit is the 100 DL oil-engined narrow-gauge surface locomotive, shown in Fig. 19. It weighs 13 tons and is a larger and heavier version of the earlier narrow-gauge locomotive. The 100 b.h.p., "6 VRHL" engine runs at 1000 r.p.m. A scoop-controlled hydraulic coupling and an "S.S.S. Powerflow" gearbox give three speeds in both the forward and reverse directions. The general appearance of this important new unit in the Ruston range of small oil locomotives down to the 20 b.h.p. at 2¾ tons can be seen in our illustration.

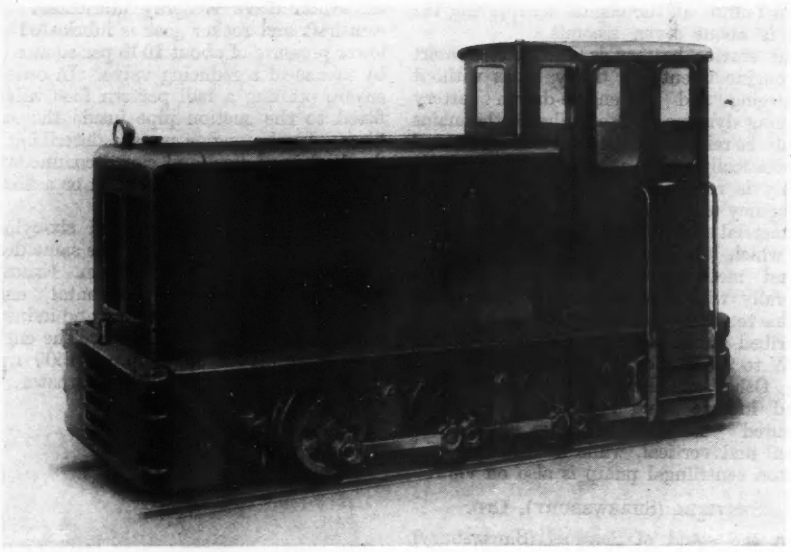


FIG. 19—NARROW GAUGE OIL-ENGINED LOCOMOTIVE—RUSTON AND HORNSBY

Among the series of marine oil and industrial engines on view on the stand, representing a range of engines from 2000 b.h.p. down to 3½ b.h.p., is a seven-cylinder "VGBM" complete with oil-operated reverse and reduction gear with a rated output of 560 b.h.p. at 430 r.p.m. A smaller marine engine is the three-cylinder "VSHM" unit, designed for outputs of 22½ b.h.p. at 1000 r.p.m. and 34 b.h.p. at 1500 r.p.m. This engine has spur gear reduction and reverse gears and a plate clutch. The smallest engine shown is a twin-cylinder "VTH" model, having a designed output of 15 b.h.p. at 1500 r.p.m.

As a contrast to these vertical engines there is exhibited the single-cylinder horizontal "6XHR" engine having an output of 34 b.h.p. at 300 r.p.m., which is illustrated in Fig. VII in to-day's Art Supplement. It is of interest to learn that there is still a very large demand for these slow-speed horizontal engines, both in the home and the overseas markets. They are well-established prime movers, and the engine shown is representative of a range of seven engines built for industrial and electrical driving, with outputs from 28 b.h.p. up to 78 b.h.p. at speeds from 320 r.p.m. down to 260 r.p.m. Two examples are shown of special generating sets for marine and industrial uses. One of these is a five-cylinder "VCBZ" engine with an output of 170 b.h.p. at 600 r.p.m., direct coupled to an electric generator. This unit is one of a range of four engines of 102 b.h.p. to 204 b.h.p. output, developed by three up to six cylinders at a common speed of 600 r.p.m. The engine incorporates standard Ruston practice and is mounted on a fabricated steel bed-plate which is extended to receive the generator.

In another of to-day's Art Supplement pictures we illustrate in Fig. VIII an example of the industrial "automatic-control mains failure" equipment, which has been designed to take charge when a failure in the main supply occurs. It consists of an oil engine-driven generator set, which works in conjunction with a control cubicle. The

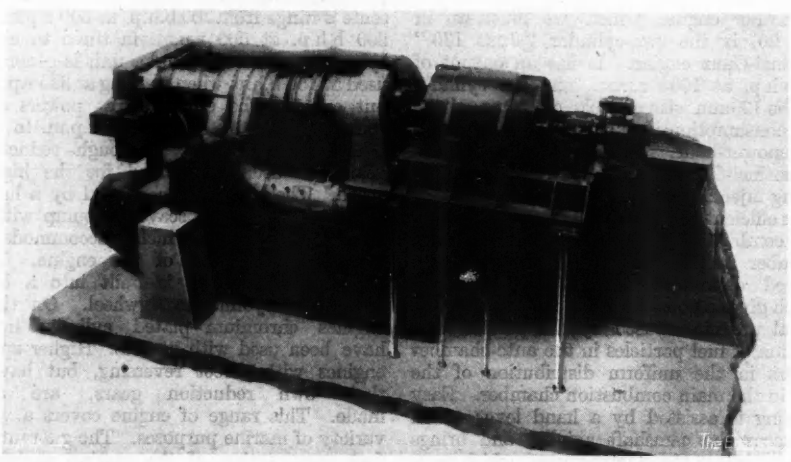


FIG 18—MODEL OF THE RUSTON GAS TURBINE—RUSTON AND HORNSBY

engine is equipped with electrical starting and stopping arrangements, all operations being initiated by the control cubicle. When the mains supply fails a series of relays and contactors remove the mains supply circuit from the load, and at the same time complete the engine starting circuit. The time taken from mains failure till the engine is supplying the load is about seven seconds.

The starter battery is designed to start the engine twenty to thirty times without recharging and an engine-driven battery charging dynamo is fitted. Should the mains supply be reinstated, the load is disconnected automatically and in a few seconds the mains supply is reconnected to the load. These emergency sets can be supplied for ordinary commercial service or for service aboard ship, for which the control cubicle includes a second method of starting and accords generally with the Ministry of Transport's marine regulations. Sets of the kind we have described can be supplied with outputs from 2½kW to 95kW d.c. or from 2½kW to 85kW a.c. Other exhibits shown on the Ruston stand include scale models of the firm's patented "Thermax" boilers, both horizontal and vertical, while an example of a Ruston centrifugal pump is also on view.

SENTINEL (SHREWSBURY), LTD.

On the stand of Sentinel (Shrewsbury), Ltd., of Shrewsbury, are shown several examples of Sentinel and Sentinel-Ganz oil engines. They include engines of the vertical and horizontal types designed for industrial use for marine auxiliary service and for transport vehicles and civil engineering plants. In Fig. VI in the Art Supplement we illustrate a six-cylinder "SRU 2" engine with a bore of 4¾in and a stroke of 5½in, the designed output being 98 b.h.p. at a speed of 1500 r.p.m. at a continuous rating.

The crankcase and cylinder block form a one-piece casting, and have dry liners with plated bores. The crankshaft, which may be of high-grade cast iron or die-forged-nitrided steel according to the engine duty, is carried in seven substantial bearings. The crankshaft has 3⅝in diameter main bearings running in steel-strip, lead-bronze bearing shells. The same type of bearing is employed for the connecting-rod big-ends, and the small-end bearing is a phosphor-bronze bush. Die-cast pistons of light alloy each carry three compression rings and a slotted scraper ring above and below the gudgeon pin. The camshaft is spur gear driven from the front of the crankshaft and is driven by a triplex chain with automatic tensioning. The fuel pump, which is of standard C.A.V. design, with C.A.V. "Pintaux" injection valve nozzles, is driven from a shaft extension with an Oldham coupling.

The cylinder heads are fitted in pairs and contain the inlet and exhaust valves, which have stellited stem and face contacts.

The rocker levers are neatly arranged in each cylinder head, and are pressure lubricated. The engine works on the four-stroke principle with the Ricardo "Comet" Mark III system of combustion, which it has been found gives a satisfactory performance over a wide range of fuels and engine speeds. Electric starting is fitted. The water pump and dynamo are driven by a twin-vee belt which can be hand tensioned with an eccentrically mounted pulley. The cooling water passes through the cylinder block water spaces, and cored passages into the cylinder heads, then across the valves and combustion chambers, leaving by the outlet pipe in which a thermostat control valve, set to maintain a maximum temperature of 180 deg. Fah., is fitted. The lubrication of the engine is effected by a gear pump, spur gear driven from the crankshaft and mounted on the front end main bearing. The oil is drawn through a gauze filter in the sump, and a fabric filter, before being delivered through an external pipe to the engine main bearings at a pressure of 45 lb per square inch. This oil also lubricates the auxiliary drive and the chain drive is spray lubricated. The camshaft and rocker gear is lubricated at a lower pressure of about 10 lb per square inch by means of a reducing valve. In order to ensure priming a ball pattern foot valve is fitted to the suction pipe inside the sump filter. In the engine we are describing the flywheel is of steel and can accommodate a standard Borg and Beck clutch or a flexible oupling.

In addition to the four and six-cylinder engines of the vertical type, the same design is available in the horizontal form. Examples of the four-cylinder horizontal engine arranged for alternator driving and industrial power drives are also on view. The engines have a rating of 65 b.h.p. at 1500 r.p.m. when coupled to a 43-kW alternator, and

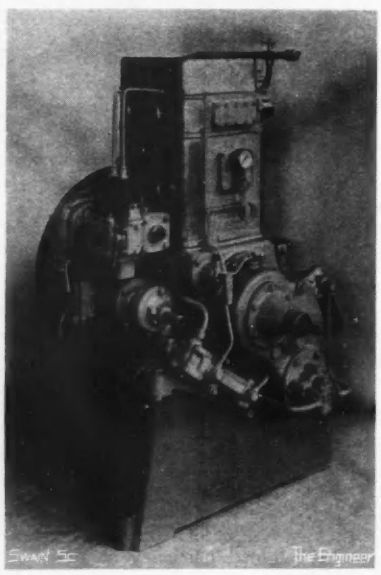


FIG. 20—26 B.H.P. OIL ENGINE—SENTINEL

90 b.h.p. at 2000 r.p.m. when used for industrial driving. In both examples the engines, along with the alternator and its electrical controls and switchgear above the industrial-drive clutch, are neatly arranged in steel covers with suitable ventilation louvres, while the necessary starting and running controls are easily available for quick operation.

Another engine, which we illustrate in Fig. 20, is the two-cylinder "JmC 130" Sentinel-Ganz engine. It has an output of 26 b.h.p. at 1000 r.p.m., and the cylinder bore is 130mm with a stroke of 160mm. The fuel consumption is about 0·42 lb per brake horsepower-hour. This engine is fitted with a Sentinel-Ganz fuel pump working on the spring-injection principle, which, it is stated, gives efficient combustion at all engine speeds. The combustion chamber comprises an ante-chamber in the cylinder head and a disc-shaped depression in the piston crown, which gives a good dispersal of fuel, while the initial pressure caused by the partial combustion of fuel particles in the ante-chamber assists in the uniform distribution of the fuel in the main combustion chamber. Easy starting is assisted by a hand lever which displaces the camshaft axially, and brings into operation the starting cams, which open the inlet valves towards the end of the suction stroke and not at the beginning. The rise of pressure and temperature thus given assists easy starting under all conditions. The robust construction of the Sentinel-Ganz engine is clearly indicated by our engraving. These engines are manufactured in a range of sizes from 26 up to 600 b.h.p.

CROSSLEY BROTHERS, LTD.

This year the exhibits of Crossley Brothers, Ltd., of Openshaw, Manchester, are shown on two separate stands. The main stand for running exhibits is in the Grand Hall, and on it are arranged four examples of marine and locomotive engines. One of the largest engines in the show, a 1500 b.h.p. marine engine, is exhibited running under its own power. The remaining three engines are motored round at a slow speed and are furnished with interior lighting and "Perspex" inspection doors, so that interior parts and their movements can be observed.

The other Crossley stand is in the Empire Hall, and it houses not only an office, but a comfortable cinema, in which the latest Crossley colour films are being shown. On this stand there is also an engine exhibit, which is a working model in part section of the twelve-cylinder "H.R. Vee" marine engine. In its design it differs very little from the full-size locomotive engine which is on view on the main stand and which we illustrate in Fig. 22 opposite. All the engines are two-stroke units operating on the loop scavenge principle, with port control of the air inlet and discharge processes and exhaust pulse pressure charging. The three sizes of cylinders, 7in bore, 10½in bore and 14½in bore, in the ranges represented by the examples shown, cover powers up to 2400 b.h.p.

The first engine on the main stand is the eight-cylinder "CRL" marine unit, which has a power and speed range from 1050 b.h.p. at 220 r.p.m. to 1500 b.h.p. at 320 r.p.m. It is compact in design and has the Michell thrust block and the three-lobed Roots blower built into the after end. The pistons are oil-cooled and the two-stage air compressor for air starting and reversing is built in, as are also the circulating water and standby or bilge pumps. The pressure gauges, control wheel, other controls, and the multi-point lubricators, are conveniently grouped at the end of the engine. Fuel consumptions as low as 0·350 lb per b.h.p.-hour are obtained on test with production engines. Such units are available for direct or geared drive to the propeller, and two engines can quite well be geared to a single shaft, giving 3000 b.h.p. on an overall length of only 31ft.

Another engine is the six-cylinder "HRL" marine engine, and is illustrated in Fig. 21. It is of the scavenge pump type and represents a range from 200 b.h.p. at 300 r.p.m. to 800 b.h.p. at 500 r.p.m. in three to eight cylinders. The six-cylinder unit is generally used at 450 b.h.p. when running at 340 r.p.m., but can also be employed at powers and speeds from 400 b.h.p. at 300 r.p.m. to 600 b.h.p. at 500 r.p.m., although reduction gears are usually included for the higher speed. The engine is scavenged by a light-weight reciprocating scavenge pump with a short tandem stroke, which is accommodated at the forward end of the engine. The Michell thrust block is built into a base extension beyond the flywheel. On these engines chromium-plated cylinder liners have been used with success. Higher speed engines with direct reversing, but having their own reduction gears, are also made. This range of engine covers a wide variety of marine purposes. The guaranteed fuel consumption of the marine engine is 0·370 lb per b.h.p.-hour.

A third exhibit is the twelve-cylinder "HST Vee" engine, designed for heavy duty locomotive service, which is illustrated in Fig. 22. Our engraving shows the engine on the test bed in the works, but on the stand it is exhibited as a unidirectional engine with a flange-mounted generator, the whole unit being carried on a three-point suspension with rubber mountings. Its designed output is 1800 b.h.p. at 600 r.p.m., but for diesel-electric applications a speed range from 400 to 600 r.p.m. is usually chosen. It can also be supplied as a direct reversing engine when used with a mechanical drive. The simple cylinder heads and the grouped controls, together with the built-in pumps and scavenge pump, make this engine very suitable for locomotive work. With exhaust pulse pressure charging it develops a high power at a moderate engine speed. The largest locomotive version is a sixteen-cylinder engine, having a designed output of 2400 b.h.p.

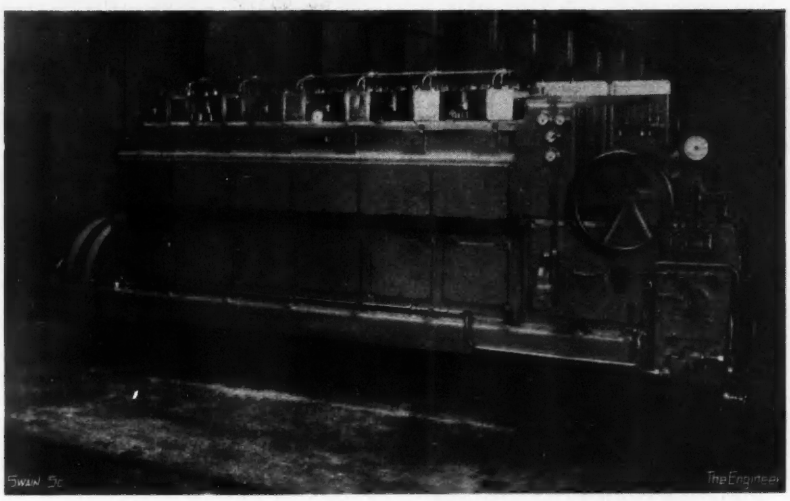


FIG. 21—SIX-CYLINDER, 450 B.H.P. MARINE OIL ENGINE—CROSSLEY

The same engine is also made as a direct reversing marine unit and the sixteen-cylinder unit has a continuous marine rating of 1600 b.h.p. The twelve-cylinder version has a continuous rating of 1200 b.h.p. at 500 r.p.m. or 1000 b.h.p. at 400 r.p.m., and it is usually fitted with reduction gearing at these speeds. At the lower speeds of 900 b.h.p. at 340 r.p.m. and 800 b.h.p. at 300 r.p.m. it is equally well suited for direct coupling to the propeller. Those who wish to study this marine and locomotive vee engine more closely will find a sectioned model of the twelve-cylinder marine engine on the other Crossley stand already referred to.

The fourth engine on the main stand is a six-cylinder "ERL" marine engine, which is widely used for smaller ships and has already been equipped with remote control, enabling engines to be controlled from the bridge. It has 7in bore cylinders and, like the other models, it is totally enclosed, but at the same time the working parts are readily accessible. The designed power range is from 180 b.h.p. at 450 r.p.m. to 300 b.h.p. at 750 r.p.m. For direct drive to the propeller the lower speeds of 450 to 500 r.p.m. are usually chosen, and for coupling through reduction gearing the higher speeds of 600 or 750 r.p.m. In several instances the Burn silent reduction gear in a 2 : 1 ratio has been successfully applied with good service results. In addition, there is shown on the stand a Crossley fuel pump made in "Perspex." Sectioned components, such as the fuel injector, are also on view. The fuel pump is common to the "HRL," "HR Vee" and "CRL" engines, and it is characterised by the port control of the suction and spill processes by means of two plungers, which are actuated by a single cam and roller line. The injector is of the latest Crossley design with a short spindle, and has a nitrogen-hardened detachable guide, a separate self-centring nozzle and convenient adjustment for the spindle lift and the spring compression. The injectors are practically similar for all types of engines, only the body length varying.

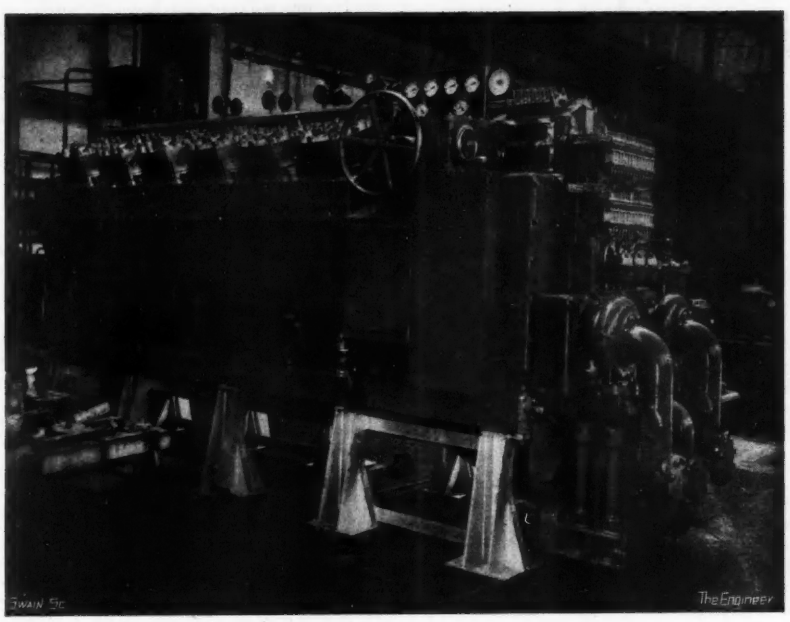


FIG. 22—TWELVE-CYLINDER, 1600 B.H.P. LOCOMOTIVE ENGINE—CROSSLEY

Among the films which are being shown we may mention "Power for Locomotives" and "Power for Ships," "Diesel Power on the River Thames," and "Exhaust Pulse Pressure Charging."

MUREX WELDING PROCESSES, LTD.

A centre of interest on the stand of Murex Welding Processes, Ltd., Waltham Cross, Herts, is the 300/400A diesel engine-driven welding equipment fitted with a new form of cartridge starter, which allows the engine to be started in an instant, under any climatic conditions, by striking a trigger.

Briefly, the equipment consists of a Dorman "4DS" diesel engine, direct-coupled to a 9-kW generator, surmounted by a control panel. The complete unit is enclosed by a substantial steel cover, the sides of which consist of four folding doors, hinged at the top to give access to the engine generator and control gear. A channel steel bed-plate carries the whole unit and is mounted with leaf springs on a four-wheeled, pneumatic-tyred trailer complete with drawbar, parking and automatic brake.

The four-cylinder Dorman engine has a bore of 90mm, a stroke of 120mm and is rated at 34 b.h.p. at 65 deg. Fah. and 1500 r.p.m. The fan-cooled radiator is divided into two sections, one for cooling water and the other for lubricating oil. A 10-gallon fuel tank is mounted under the canopy.

Flexibly coupled to the engine is a 9-kW drooping-characteristic, single-control, self-stabilising generator, the output of which can be varied by combined series and field control from 50 to 300A at 30 arc volts. On open circuit the arc voltage rises to about 70V. The generator has class "B" insulation throughout. A portable regulator enables the operator to adjust the output without having to return to the set.

Another interesting Murex exhibit is the 150-c/s alternator set, which is illustrated in Fig. XI in the accompanying Art Supplement. The equipment is a four-operator unit with an output of 300A per operator, and it consists of a 150-c/s alternator direct-coupled to a three-phase induction motor which can be connected to any standard three-phase supply. Excitation for the alternator is obtained from a "Magnicon" exciter, which is designed to maintain the welding voltage within close limits. The use of a frequency as high as 150c/s simplifies the job of maintaining steady arc conditions and makes it possible to use smaller and more portable regulators.

MIDLAND DYNAMO COMPANY, LTD.

An adjustable armature-winding machine, claimed to be the first of its kind manufactured by a British firm, is exhibited by the Midland Dynamo Company, Ltd., Leicester. In the form exhibited the "Quickway" armature-winding machine is suitable for the manufacture and repair of all sizes of

fractional horsepower motors, such as those used in domestic appliances and portable tools. Another version of the "Quickway" machine is available to cater for larger armatures up to about 3 h.p.

An illustration of the smaller machine is reproduced in Fig. XV in the Art Supplement. It will be seen that the armature to be wound is supported between two widely adjustable centres fitted with a quick-acting, half-turn lever operating a cam-shaped locking device whereby the armature can be locked, released, or made free to spin. The conductor wire is fed from the bobbin over pulleys mounted on the winding arm, which is rotated by the geared driving motor. Rotation of the winding arm feeds the conductor wire into a pair of slots, with the help of two pairs of finger guides which are readily adjustable by means of knurled nuts. The number of turns laid in each pair of slots is indicated by a turn-counter, which can be reset for the next operation after each pair of slots has been filled.

In its latest form, as designed for winding on a mass-production basis, the machine incorporates a number of improvements. It is fitted with a preset counter which automatically stops the winding operation at the desired number of turns per slot. The power unit is a geared electric motor with a variable-speed range from zero to 500 r.p.m. An electrically operated brake on the high-speed shaft of the motor gives smooth deceleration. Where continuous slot insulation is permissible, a specially designed fixed winding head can be used, to give increased speed when indexing for the next slots to be wound. Control of the driving motor is by a push button mounted at the front of the machine. A switch panel on the side of the equipment houses "on-off" and "forward-reverse" switches, together with a sliding control for increasing or decreasing torque.

A simple, adjustable spring-controlled wire-tensioning device is incorporated in the pulley system on the winding arm, and a very wide range of winding wires from 45 s.w.g. to 24 s.w.g. can be used, with winding speeds up to 500 turns per minute. A special revolving winding spindle is available, to enable the maximum winding speed of 500 turns a minute to be obtained without difficulty when wires as fine as 47 s.w.g. are in continual use.

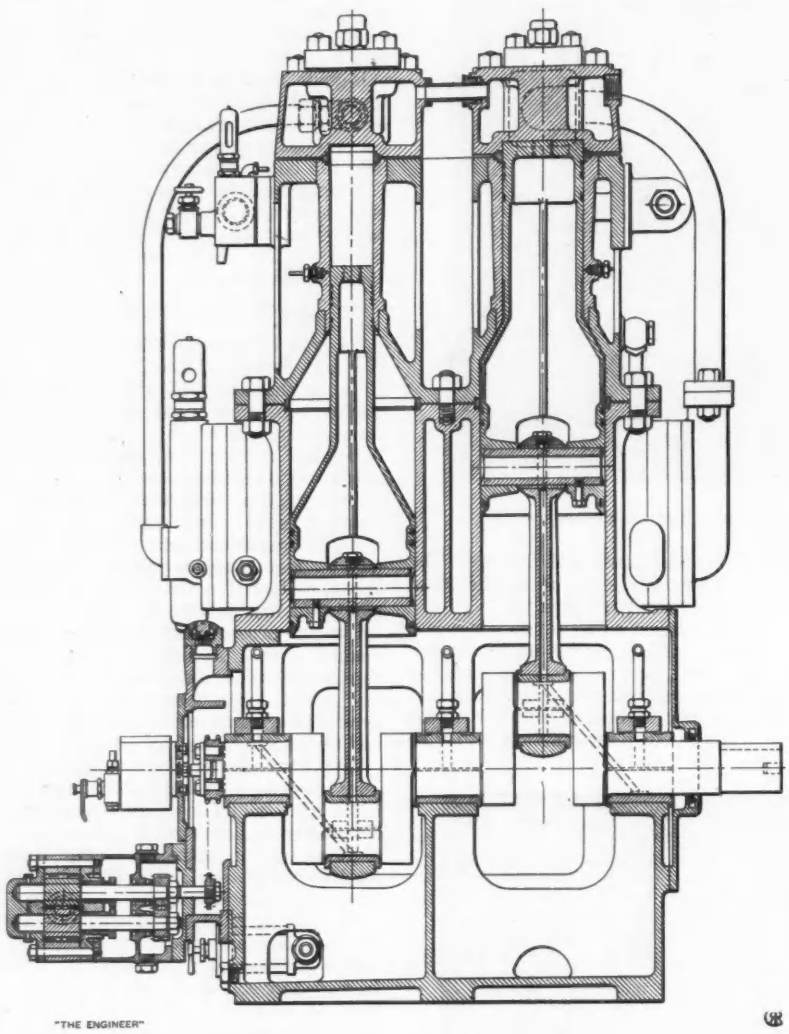


FIG. 23—ARRANGEMENT OF COMPRESSOR—HAMWORTHY

HAMWORTHY ENGINEERING COMPANY, LTD.

Three single-acting starting air compressors shown by the Hamworthy Engineering Company, Ltd., of Poole, for the first time include the two-crank, three-stage, machine illustrated in Fig. XX in the Art Supplement. This machine is intended for diesel engine main starting duties and has a continuous rating of 163·5 cubic feet per minute free air delivered against a pressure of 600 lb per square inch at 500 r.p.m. It is shown running at slow speed with the motion work illuminated and visible through transparent crankcase covers.

As can be seen in the drawing reproduced in Fig. 23, the first-stage compression occurs in annular spaces on both lines of motion work with the second and third stages of compression effected on the upper buffer portions of the pistons.

The crankcase, cylinder blocks and cylinders are of close-grained cast iron, and the alignment of the two cylinder blocks—each of which has two bores—is ensured by the use of double spigots. The second and third-stage cylinder heads are also located in alignment by spigots.

The journals of the forged crankshaft are precision ground to accommodate the main and big-end bearings, which are of gunmetal lined with high-grade white metal and fitted with shims. Each of the close-grained cast iron pistons has an adequate number of cast iron spring pressure rings and the first-stage piston skirts are fitted with scraper rings. All bearings are pressure lubricated by a gear pump driven from the crankshaft. The first-stage cylinder walls are mist lubricated from the crankcase and a mechanical lubricator driven from the crankshaft feeds oil to the second and third-stage cylinder walls.

Low-lift plate valves of chrome-vanadium steel are made easily accessible for servicing purposes. The external air connections between the first and second stages are of the flanged type and those of the third stage are forged steel "Ermeto" compression couplings. Extractable elements are fitted in the intercoolers, which are bolted to the main frame and can be quickly removed. Drain cocks are fitted to all the coolers together with relief valves of the high-lift type having stainless steel valves and seats. Each tube nest is formed from solid-drawn hard copper tubes expanded into tube plates of rolled naval brass.

The low compression ratio employed makes it necessary to employ air cooling to maintain the cylinder walls at a temperature sufficient to prevent condensation and its resultant corrosion and wear. The first-stage valve pockets, intercoolers, second and third-stage cylinder heads and the aftercooler are water cooled. Water for cooling purposes can be supplied from a connection to the mains or by means of a positive displacement pump driven from the crankshaft. A bursting flange in the system has a deflector which, in the event of excessive jacket pressure, directs the water away from the driving motor.

It is interesting to note that one of these machines is to be used in connection with a chemical process requiring a compressor for continuous twenty-four-hour operation. In this case the machine will be driven by a variable-speed motor, which will be controlled automatically by the pressure in the receiver. At the lower limit of motor speed the set automatically stops and starts again when the demand increases. The control gives simple adjustment over a wide range of operating pressures and is also intended to dispense with the use of unloading gear.

One of the two other new machines on the stand is a single-crank, tandem, two-stage compressor for emergency and auxiliary starting purposes. It has a continuous rating of 13·1 cubic feet per minute free air delivery at 1000 r.p.m. against a working pressure of 450 lb per square inch. This exhibit is sectioned to show the compact arrangement and the accessibility of the valves and coolers. The other machine is a two-crank, two-stage compressor for main and auxiliary starting duties. It is direct coupled to a marine-type electric motor on a fabricated

steel bed-plate and is continuously rated to deliver 51 cubic feet per minute of free air against a working pressure of 1000 lb per square inch at 750 r.p.m. In this machine the valves, coolers and working motion are readily accessible and a built-in instrument panel enhances its neat appearance.

Also to be seen on this firm's stand are two horizontal gear pumps for pressures up to 300 lb per square inch. These pumps are used extensively for oil-firing and transfer duties for both land and marine installations. Other rotary displacement type pumps include a 5in vertical-spindle, marine-pattern gear pump with a capacity of 60 tons per hour, and the "Transflo" pump, suitable for the pumping of viscous liquids such as bitumen, crude oil, hot waxes and resins, soap and molasses.

A new design of marine-pattern vertical-spindle centrifugal pump shown has 5in/6in branches and is of split casing design. It has been developed particularly for forced lubrication, piston cooling, and diesel and furnace fuel-oil transfer duties.

The main frame of this pump can be constructed of fabricated steel or cast iron, as preferred, and forms a rigid attachment between the pump unit and the driving motor. It carries the suction and delivery branches and takes the weight of any unsupported pipework to eliminate the possibility of distortion and misalignment of the pump unit.

The suction and delivery connections between the main frame and the pump unit form the pump seating, on which location is effected by dowel pins. By breaking this single flat joint and removing the bolts from the flexible coupling the pump unit can be detached complete from the main frame without disturbing the pipe connections.

The casing is split in the plane of the rotors and spindles, the halves being located by means of four fitted bolts. The metal-to-metal joint between the halves is hand scraped prior to machining the rotor bores. The rotors are formed from "Nitralloy" blanks and are mounted on spindles of 3 per cent nickel alloy steel, which are case-hardened and ground. Each spindle runs directly on two needle roller-bearings and the weight of each rotor and spindle is taken by a ball thrust bearing, which also locates the rotor to provide the requisite axial clearances.

A deep stuffing-box is fitted with a lantern ring connected to the pump suction so that the gland is under negligible pressure. Any gland leakage is collected in a tundish fitted with a drain cock or plug as required. A spring-loaded bypass valve housed in the main frame protects pump, motor and pipe-line equipment against overload. This valve is of the balanced piston type, in which the fluid load on the ported valve is balanced partially by delivery pressure on an opposing piston. The small residual load is resisted by the control spring, which, being of small dimensions and low rate, minimises the pressure increase at maximum bypass conditions. The valve is set normally to lift at about 10 lb per square inch above the working pressure, and may be adjusted by a tension screw.

The pump handles oils of widely differing characteristics at pressures up to 100 lb per square inch, and can be adapted to operate at greater pressures or with fluids necessitating the employment of special materials or modified forms of construction.

ALMIN, LTD.

The products of the two main suppliers of the Associated Light Metal Industries Group are shown on the stand of Almin, Ltd., Farnham Royal, Bucks.

Southern Forge, Ltd., the suppliers of sections, tubes, pressings, &c., in aluminium alloys, in addition to presenting a representative selection of its products, has constructed two sections of a fish hold for a trawler which has been built entirely in aluminium. For this hold a single type of aluminium extrusion has been used for the stanchions. These stanchions, in addition to providing rigid structural members, incorporate provision for carrying the fish boards.

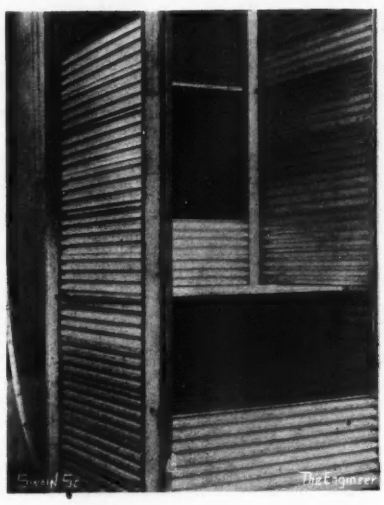


FIG. 24—ALUMINIUM FISH HOLD—ALMIN

Each fish board is of standard dimensions and is made of an aluminium extrusion, which is corrugated to impart additional stiffness. The stanchions are 16ft high and the fish boards can be slid down grooves in their sides to form the sides and platforms of the hold, as shown in the illustration Fig. 24. It is pointed out that the strength, lightness and hygienic qualities of the aluminium fish hold give it many advantages over the type of hold with steel stanchions and wooden boards.

The other member of the group, Renfrew Foundries, Ltd., is showing a range of castings which include scavenge pipes, diesel engine sumps, manifolds, &c.

REDIFON, LTD.

The "IH 40" radio-frequency induction heater is a recent addition to the industrial equipments manufactured by Redifon, Ltd., Broomhill Road, Wandsworth, London, S.W.18. Designed to bridge the gap between the "IH 39" and "IH 5" equipments (which have outputs of 7kW and 25kW respectively), the new equipment is a compact unit with a specified continuous output of 13kW or 14kW on short-cycle heating for hardening, brazing, annealing, melting or other industrial applications. The main particulars of the equipment are tabulated herewith :

Output power (continuous) :	ferrous loads ...	13kW
	brass loads ...	4·5kW
Output frequency (nominal)		550kc
Maximum circulating current in work coil (approx.)		400A
Maximum voltage across loaded work coil (R.M.S.) (approx.)		1·25kV
Height of work coil from ground		4ft 3in
Mains input...		380/440V, 50c/s, 3-phase
Power factor at full load (line current 42A) ...		0·95
Power consumption : standby		1·2kW
full load		29kW

Two naturally-cooled industrial type silica-triode valves form the basis of a power oscillator circuit designed for the efficient delivery of maximum power into a variety of loads. An interesting point about this circuit is the provision of a bank of condensers for tuning the work coil. This arrangement allows the circulating current to be increased when heating non-ferrous loads, the maximum current (r.m.s.) under these conditions being approximately 400A. These condensers are conveniently housed behind a removable panel above the main controls.

Ventilation and cooling of the equipment is effected by a motor-driven fan of ample capacity, drawing air through a renewable fibre-glass filter which helps to keep the interior of the equipment clean when working in a dusty atmosphere.

The photograph reproduced in Fig. XVIII in the accompanying Art Supplement gives a general view of the "IH 40" equipment with the side panel removed to show the grouping of switchgear, relays, fuses, service hour-meter, &c. Access to the opposite side of the unit is not normally required for maintenance purposes and this side therefore accommodates the output terminals.

Mounted on the front panel are the main indicating meters for anode and grid currents, together with indicator lamps, power control handwheel and process timer dial. The handwheel is normally used to provide smooth control of output power when setting up the equipment for a new application. Thereafter, the process timer exercises close control of the heating cycle ; four alternative ranges are available, for the following intervals :—0 to 10 seconds, 0 to 100 seconds, 0 to 10 minutes, and 0 to 50 minutes.

"On" and "off" push buttons are provided on the front instrument panel, but operation can be made fully automatic, if required, with the use of the process timer. An additional warning lamp indicating "R.F. power on," and an emergency "off" button are situated above the work coil. On the same side of the unit there is a socket for remote control operation, together with another socket for feeding impulses to conveyor belts, or automatic quenching or other devices timed by external handling equipment.

A separate compartment at the back of the cubicle houses the oscillator and additional meters, and a removable rear panel gives ready access to all the components. All removable panels and inspection covers are fitted with interlock switches to ensure safety of operating personnel.

The coil cooling water feed is external to the equipment, but is linked to a pressure-control switch, which automatically shuts off r.f. power if the water pressure fails or falls below a predetermined value.

PELAPONE ENGINES, LTD.

On the stand of Pelapone Engines, Ltd., of Lofthouse Gate, Wakefield, and 14, Berkeley Street, London, W.1, is shown the new light-weight, high-speed Pelapone-Ricardo diesel engine, illustrated in Fig. V in the Art Supplement. This engine, model 64, has been specially designed for stationary and portable uses, such as generating plant, pumping plant and air compressor driving, and the operation of mechanical handling equipment, including transport uses on road and rail. It is a four-cylinder unit having a bore of 3·5in with a stroke of 5·0in and a swept volume of 3·15 litres. The intermittent rating is 22 b.h.p. to 46 b.h.p. at speeds from 1000 r.p.m. to 2200 r.p.m. and twelve and twenty-four-hour ratings of 20 b.h.p. and 30 b.h.p. and 18 b.h.p. and 27 b.h.p. at 1000 r.p.m. and 1500 r.p.m. respectively. These ratings, we are informed, are in accordance with B.S. 649, at 85 deg. Fah. and at altitudes not exceeding 500ft and are net after deducting the power for driving auxiliaries, such as

the water circulating pump, the fan and the charging dynamo. The weight of the engine, including the dynamo and starter and flywheel, is 1050 lb. At 1500 r.p.m. and 30 b.h.p. the fuel consumption is about 0·414 lb per b.h.p.-hour of light diesel oil. As our engraving indicates, the cylinder block is made integral with the crankcase, and below the crankcase is the oil sump. Nickel-chrome iron is used for the main casting, which is bored out to receive dry replaceable liners made of "Vactric" hardened cast iron. All the cylinder bores are precision honed. The cylinder head is cast in a single unit, also in nickel-chrome iron, and the head contains the Ricardo "Whirlpool" combustion chamber and the valves and rocker gear. The crankshaft is made from a drop forging of nickel-chrome-molybdenum steel, which is heat-treated and ground, the flywheel being spigoted to a flange integral with the shaft. Five main bearings are provided. The pistons are made of "Heplex" die-cast lightweight alloy, and they have flat tops with three pressure rings and two oil scraper rings. The gudgeon pins are of the fully floating pattern. The five bearing camshaft is driven from the crankshaft by a triple roller chain with an automatic chain tightener. The valve rockers are actuated by means of short push rods. The auxiliaries include a 12-V C.A.V. starter and a belt-driven charging dynamo, with their automatic cut-out, contactor and switch. The lubrication is effected by a rotary pump, which draws oil from the sump through a filter and delivers it through a delivery filter and a relief valve to the main crankshaft bearings, the connecting-rod big ends and the overhead valve rockers. Good access to the fuel injection nozzles and the filters is provided. A cut-away model to show internal construction is also on view. Other models shown on the same stand include the model 52 twin-cylinder, 20 b.h.p. unit, running at 1000 r.p.m., direct coupled to a 12-kW d.c. drip-proof generator. The engine is radiator cooled, as is also the same

Fig. 25—Continuous Plan Printer—Mason

model arranged as a "power package" in a weatherproof housing, with a designed output of 20 b.h.p. to 25 b.h.p. at speeds from 1000 r.p.m. to 1250 r.p.m.

E. N. Mason and Sons, Ltd.

Some interesting drawing-office equipment of new design is shown for the first time by E. N. Mason and Sons, Ltd., of Arclight Works, Colchester.

One of the new machines, a plan printer, combines the best features of the firm's well-known "Arclight" continuous photo copier with a number of new developments. This machine—see Fig. 25—is strongly built from pressed steel and all working parts are entirely enclosed to eliminate glare from the lighting units. It is finished in metallic grey and its clean lines give it a particularly pleasing and workmanlike appearance. The switch panel and front edge of the 42in wide feed table are of stainless steel.

In order to make the internal mechanism easily available for cleaning and inspection

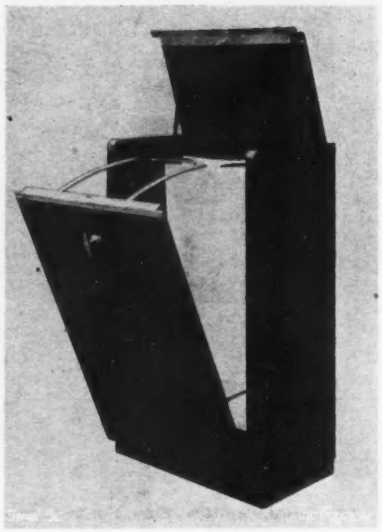


Fig. 26—Vertical Plan Filing Cabinet—Mason

the whole front of the machine and both end covers can be detached in a few minutes.

The machine is driven by a constant-speed motor through an infinitely variable-speed friction drive by which any required printing speed up to 14ft per minute is quickly and easily obtained. In order that an operator can retrieve a tracing for adjustment a reverse-feed speed of 4ft a minute is incorporated and can be engaged by pulling the control lever backwards. A special paper pick-up feeding roller on the machine is designed to pass the paper and tracing immediately on to the travelling blanket and enables small prints to be made without wasting materials. A paper cutting slot is provided in the feed table surface and a detachable rod below the table takes a 50-yard roll of printing paper.

Blanket tracking difficulties have been overcome by the introduction of an automatic tracking control gear, which tracks the endless blanket in correct alignment and tension under all temperature conditions and requires no adjustment of any kind on the part of the operator.

A particularly effective system of filing plans has been introduced to facilitate and speed the finding and storage of plans, drawings and maps. The cabinet used for the system is shown in Fig. 26. It is designed to provide the maximum protection and eliminate any tendency to curl the maps or drawings might have. This cabinet of pressed steel is supported on a recessed plinth and its internal dimensions are 32in wide, 18in deep and 49in high. In its upper part two plated full-depth parabolic steel rods are fitted in the rear and in the front panel. The lid opens to about 60 deg. and the front panel to about 30 deg., both being retained by stays which sink in recesses.

In the cabinet each plan is suspended from an individual holder which remains attached for all purposes including copying. These holders consist of pre-punched manilla strips and their edges have a coating of solution which, when moistened, firmly secures the plan. For filing, the holder and plan are simply slipped on the parabolic curves in the predetermined order. Tabbed guide sheets are used to divide a plan into sections corresponding with the divisions laid down on a visible index, which also indicate the plan titles. When it is required to remove a plan from the cabinet the handle is turned and the lid, which is spring-counter balanced, is released. By inserting a hand behind the required plan and allowing the hinged front panel of the cabinet to open, the plan can then be removed through the gap between the ends of the curved bars, as shown in our illustration.

A new drafting stand on which a very wide range of board positions is attainable with a minimum of effort on the part of the draughtsman, is illustrated in Fig. 27. This stand is intended for use with either a "Double Elephant" or "Antiquarian" drawing board with a drafting machine, straight edge parallel movements or tee-square fittings. The board cradle is counterbalanced and by depressing the back bar of a pedal the cradle support assembly can be unlocked to permit the adjustment of the board from horizontal to vertical in a forward or backward position. The assembly is relocked by depression of a front pedal bar.

The ends of the stand are of cast iron, accurately machined to ensure rigidity with ease of movement for the whole assembly. These ends are of sufficient weight to make holding down screws unnecessary even with the board in its most overhung position.

The pivot bar assembly incorporates a

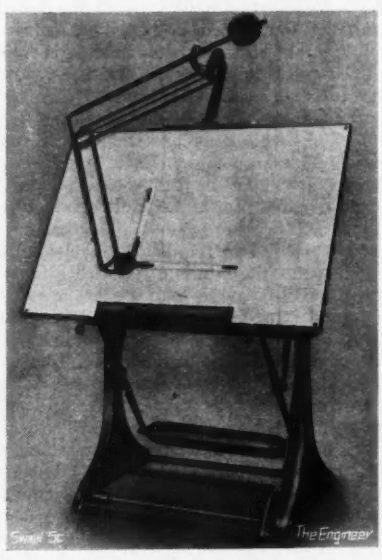


Fig. 27—Drafting Stand with Drafting Machine—Mason

damping mechanism and a limiting device which makes it impossible for the counterweight to strike the draughtsman's feet.

The pedal, of mild steel rods, is covered with rubber and is designed to provide the easiest clamping motion combined with comfort when used as a foot rest. This pedal is adjustable to suit individual requirements.

The board support or cradle is made from heavy gauge mild steel, welded to give a rigid frame strong enough to support both drawing board and drafting machine. No load is taken by the board itself.

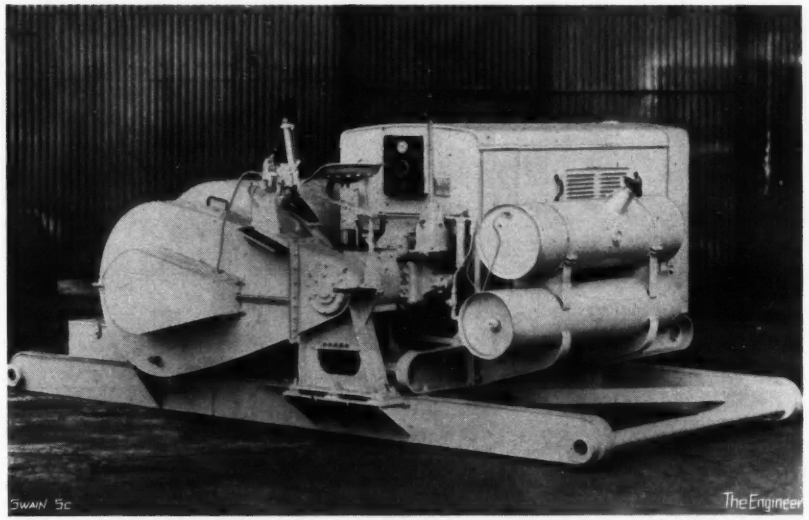


FIG. I—OIL ENGINE COUPLED TO WOODFIELD REEL—A.E.C.

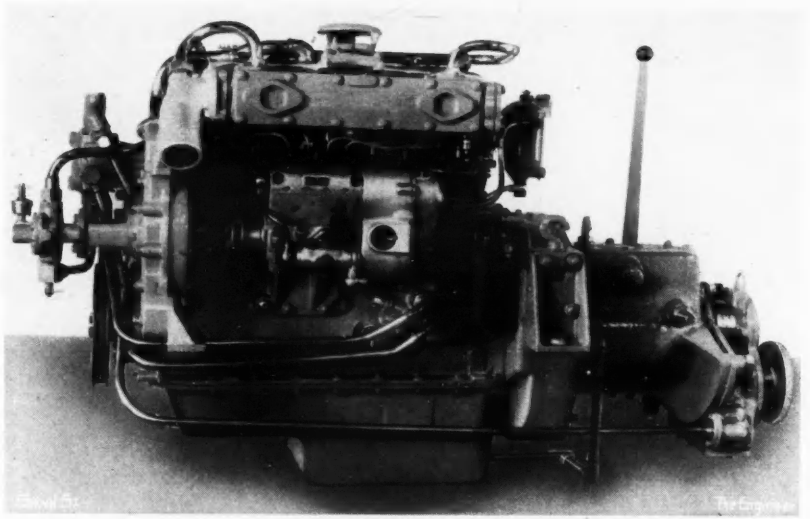


FIG. II—30 B.H.P. MARINE ENGINE—THORNYCROFT

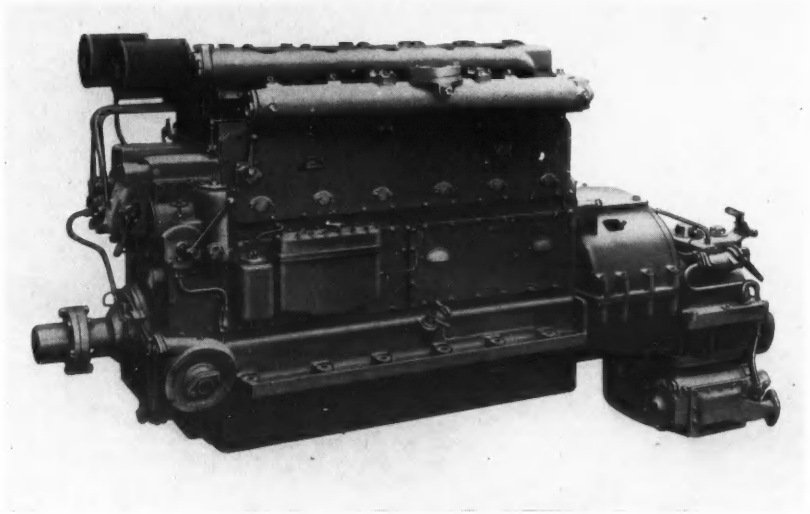


FIG. III—132 B.H.P. MARINE PROPULSION UNIT—NATIONAL

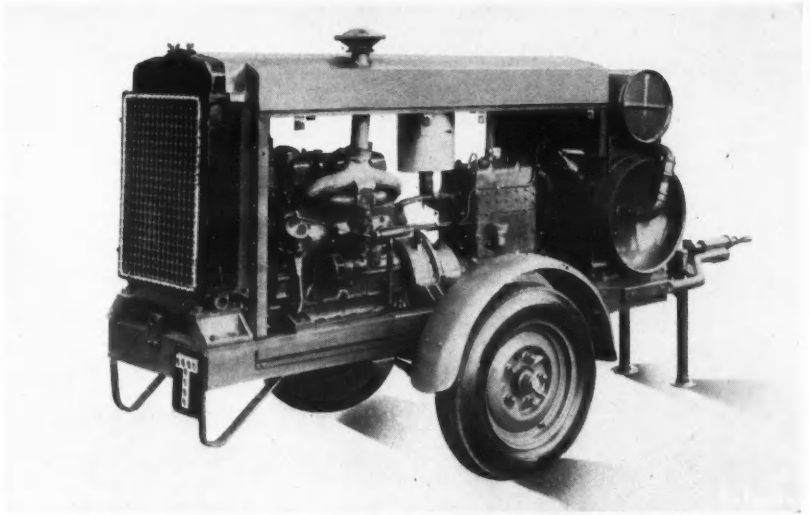


FIG. IV—PORTABLE AIR COMPRESSOR—BROOM AND WADE

OIL ENGINES AT OLYMPIA

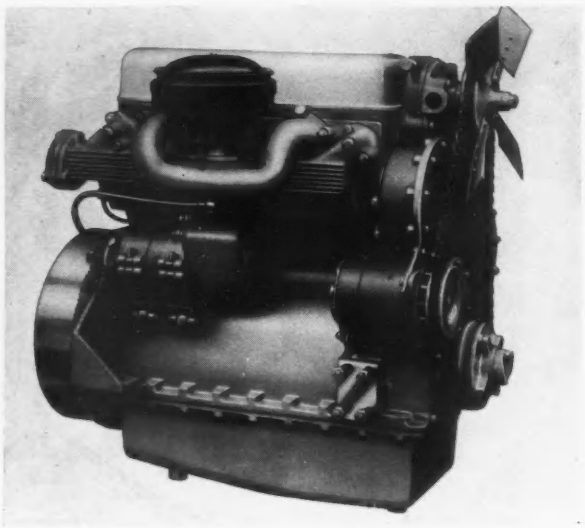


FIG. V—30/46 B.H.P. OIL ENGINE—PELAPONE

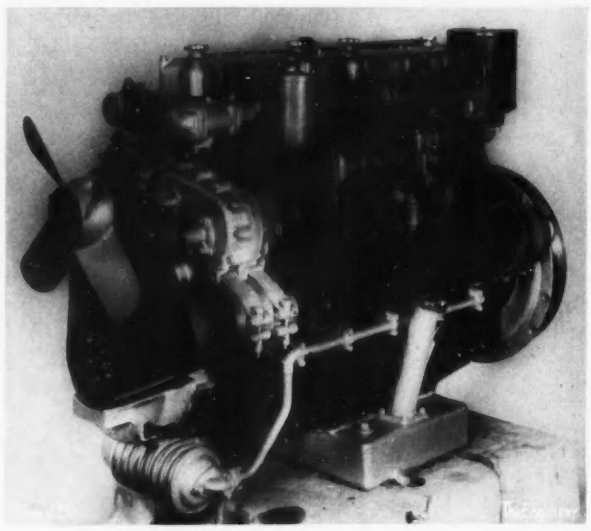


FIG. VI—98 B.H.P. OIL ENGINE—SENTINEL

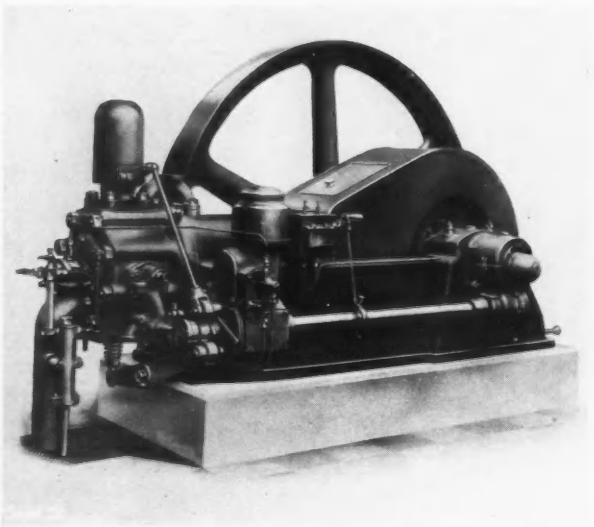


FIG. VII—34 B.H.P. HORIZONTAL OIL ENGINE—RUSTON

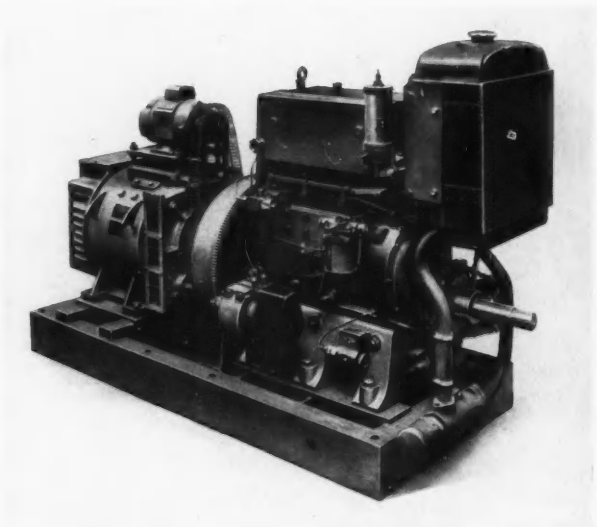


FIG. VIII—50 B.H.P. EMERGENCY GENERATING SET—RUSTON

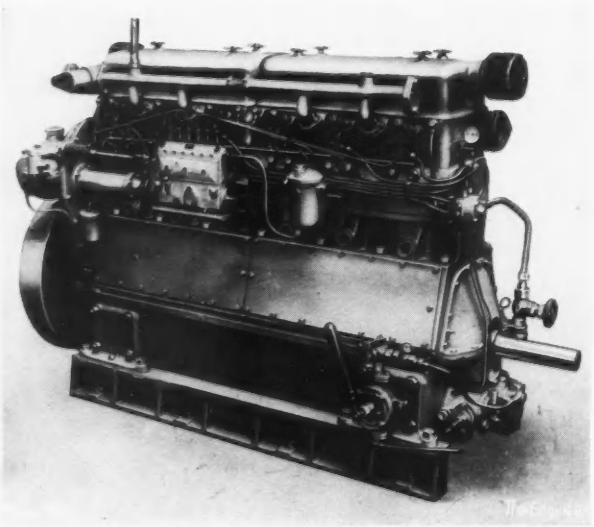


FIG. IX—140 B.H.P. MARINE OIL ENGINE—PAXMAN

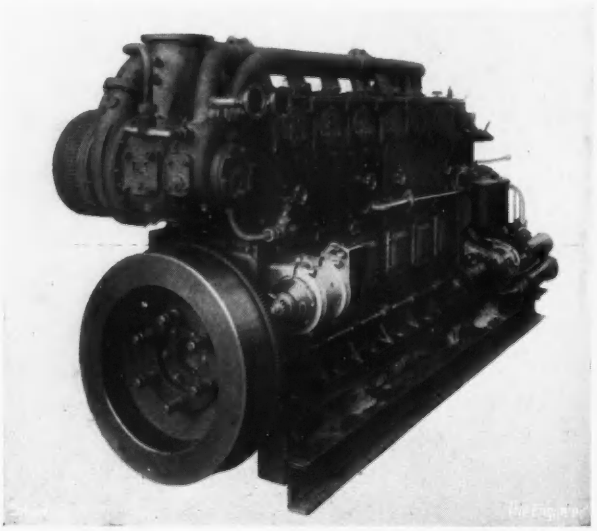


FIG. X—145 B.H.P. OIL ENGINE—RUSSELL NEWBERY

EXHIBITS AT OLYMPIA

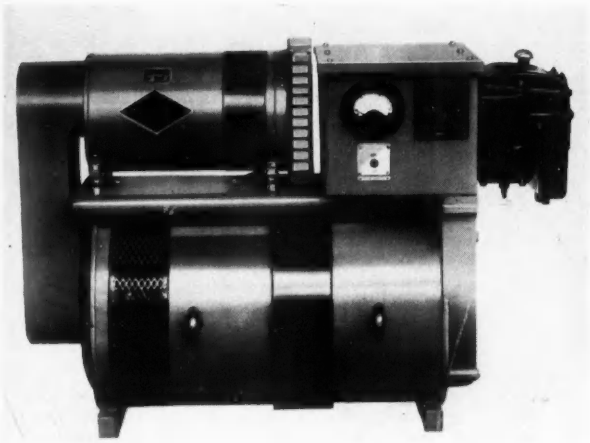


FIG. XI—150-CYCLE ALTERNATOR WELDING SET—MUREX

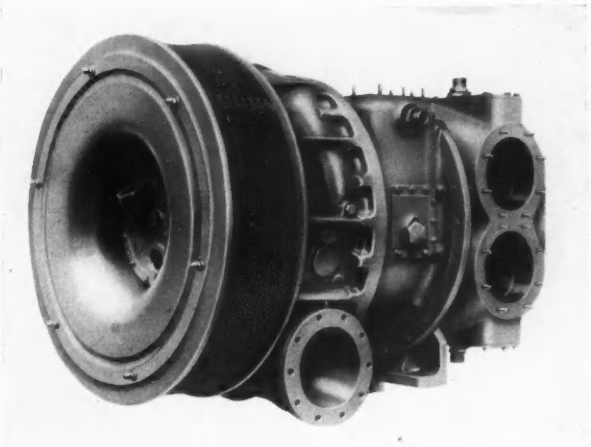


FIG. XII—TURBO-BLOWER—NAPIER

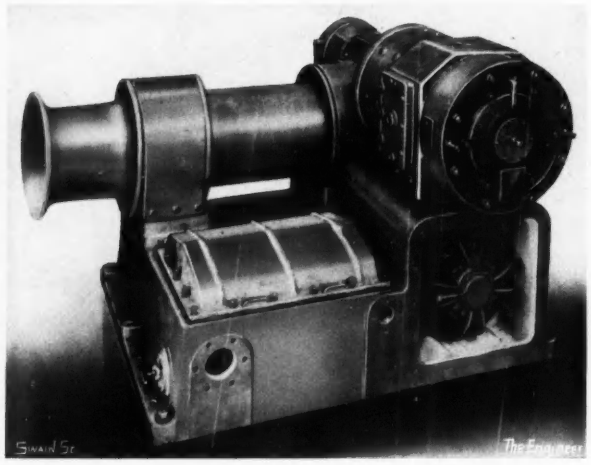


FIG. XIII—"CONVERTOR" WINCH—LAURENCE SCOTT

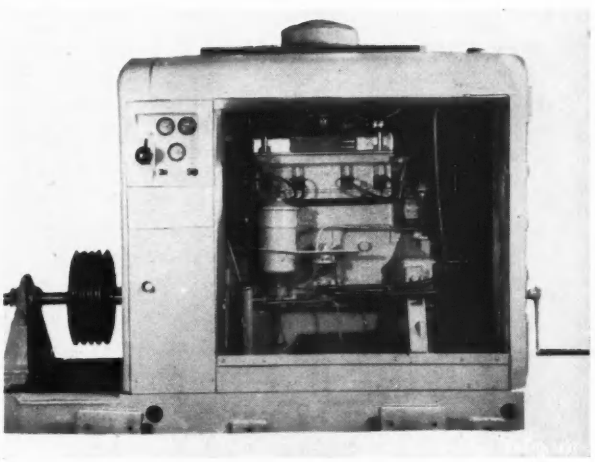


FIG. XIV—PETROL/NATURAL GAS ENGINE—MEADOWS

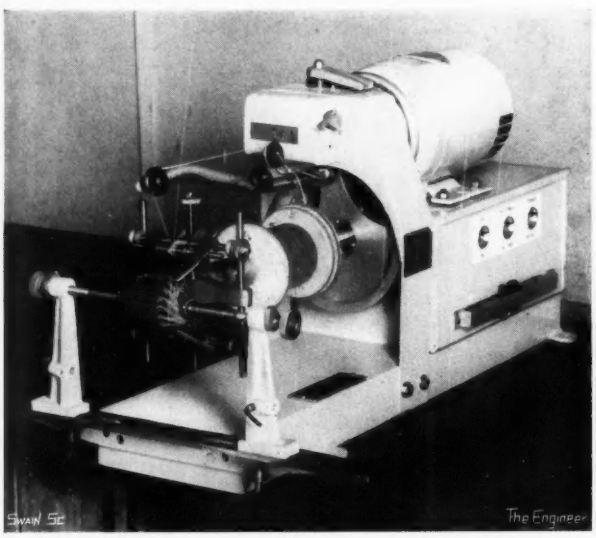


FIG. XV—ARMATURE WINDING MACHINE—MIDLAND DYNAMO

FIG. XVI—ARGON ARC-WELDING PLANT—ARC MANUFACTURING

EXHIBITS AT OLYMPIA

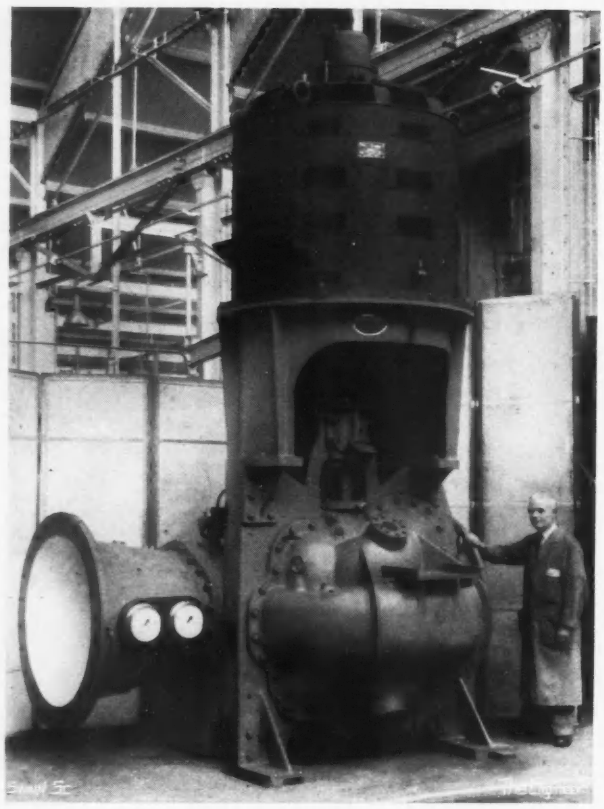


FIG. XVII—VERTICAL CIRCULATING WATER PUMP, 550 H.P.—ALLEN

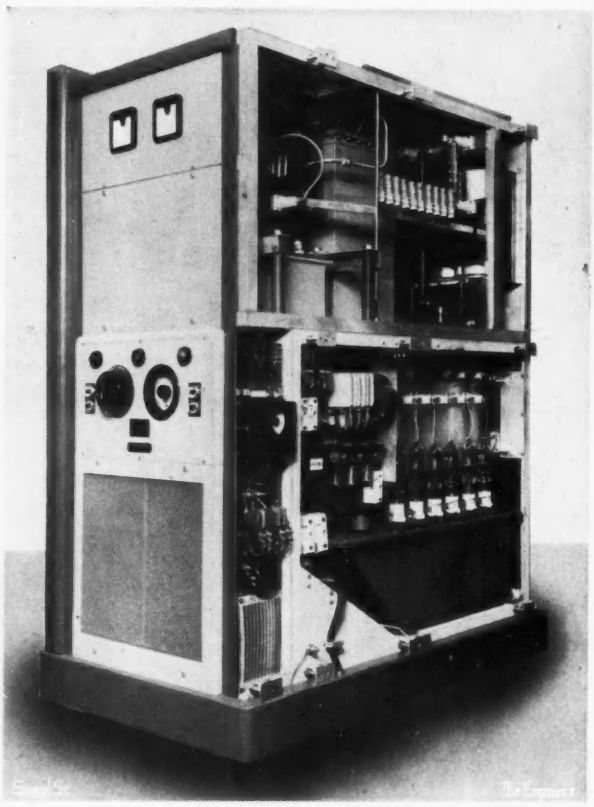


FIG. XVIII—INDUCTION HEATER,—REDIFON

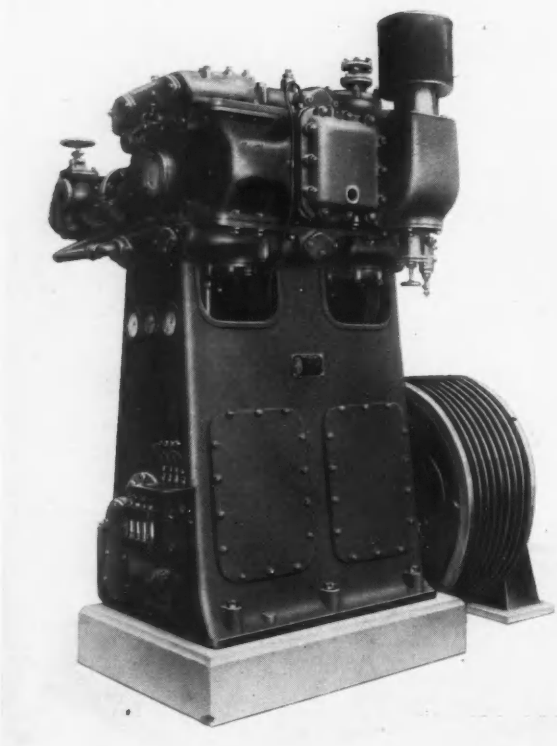


FIG. XIX—AIR COMPRESSOR—ALLEY AND MACLELLAN

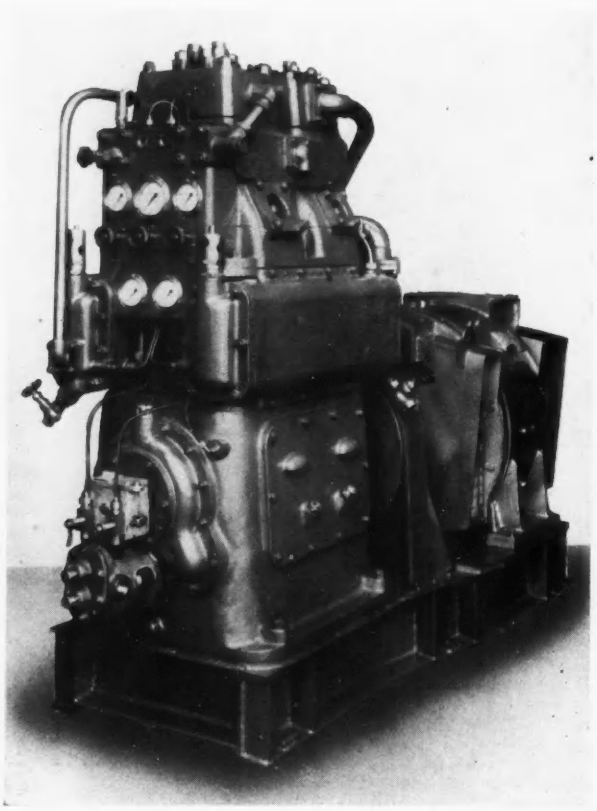
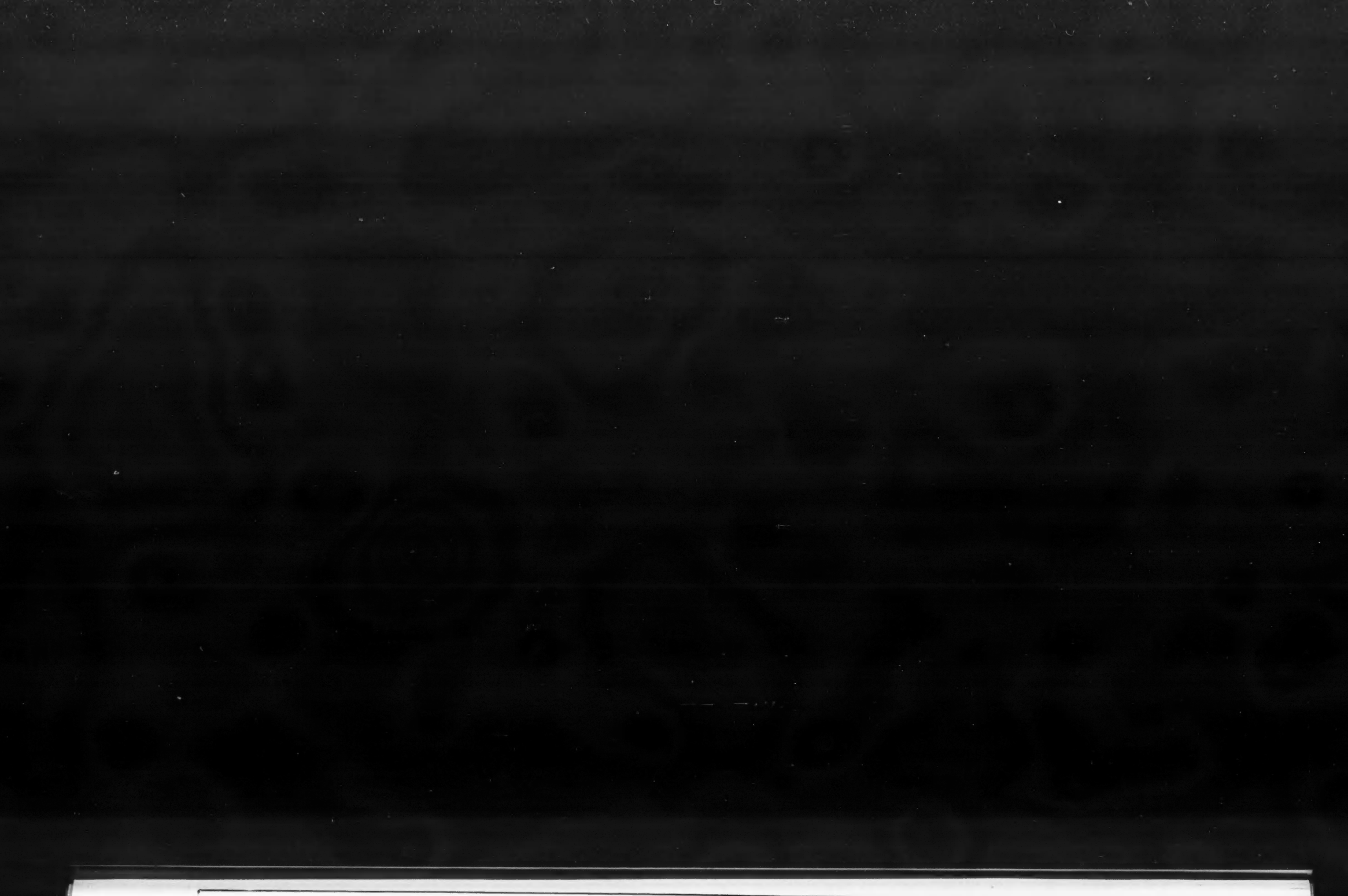


FIG. XX—THREE-STAGE AIR COMPRESSOR—HAMWORTHY



A Seven-Day Journal

The Engineering and Marine Exhibition

THE official opening ceremony of the seventeenth Engineering and Marine Exhibition to be held at Olympia, London, was performed on Thursday of last week by Sir John Anderson, F.R.S., Honorary President of the Exhibition. The ceremony was followed by a luncheon at which Sir John presided, and which was attended by many guests from home and overseas. Following the loyal toasts, "Success to the Exhibition" was proposed by Sir Percy Lister, who referred to the fact that the Exhibition was the largest so far held, the actual number of exhibits being 75 per cent greater than pre-war. It reflected great credit on the part of the organisers, F. W. Bridges and Son, Ltd., and, Sir Percy continued, it emphasised that the country could take heart from the accomplishments of the engineering industry. In responding to the toast, Sir John Anderson stressed the need for productive efficiency, but added that its goal would not be reached without effective salesmanship. He went on to refer to the great strides in metallurgical processes which had been made in this country, in which respect, he thought, the exhibition indicated a very important aspect of productive efficiency. If, Sir John commented, there were things taking place in the world to-day which were inclined to make people pessimistic, there was nothing beneath the roof of Olympia to promote anything but optimism. He did not think it was possible to find anywhere a greater or finer display of high-quality engineering productions. Engineers, Sir John concluded, must go on "telling the world," for the merits of British design were not yet recognised everywhere. The final toast at the luncheon was that of "Our Guests from Home and Overseas," which was proposed by Lieut.-Colonel H. Riggall and acknowledged by Dr. H. Roxbee Cox and His Excellency Senor Don Manuel Bianchi, Chilean Ambassador.

Two Liner Launches

ON Thursday, August 25th, the Union Castle motor liner "Bloemfontein Castle." was launched at Harland and Wolff's Belfast shipyard. The naming ceremony was performed by Mrs. Leif Egeland, the wife of the High Commissioner for South Africa. The liner is the first of the intermediate class to be built for the Union Castle Line since before the war, and she will be slightly larger than the "Durban Castle" and the "Warwick Castle." She has an overall length of 595ft with a breadth moulded of 76ft, a depth moulded of 37ft and a gross tonnage of about 17,800. Her twin-screw propelling machinery comprises two double-acting, two-stroke, eight-cylinder engines of Harland and Wolff design, with a cylinder bore of 620mm and a stroke of 1400mm. Steam is furnished by two Cochran oil-fired boilers and two Clarkson waste heat boilers. The electrical plant includes four 450-kW, H. and W., diesel-driven generators, and a 75-kW diesel-driven emergency generator. The "Bloemfontein Castle" is designed to carry 700 passengers in one class, and she will have considerable cargo space, of which 186,000 cubic feet will be insulated for the carriage of refrigerated cargoes. At Vickers-Armstrongs naval construction works at Barrow-in-Furness, on Thursday, August 25th, the second of three 14,000-ton passenger and refrigerated cargo liners, designed and built for the Instituto Argentino de Promotion del Incambio, was successfully launched. She is a sister ship to the "Presidente Perón," which recently made a successful maiden voyage to Buenos Aires. The launching and naming ceremony was performed by Senora Elvira del Pino de Morello, the wife of Colonel Morello, the Military Attache, on behalf of Senora de Castro, the wife of the Minister of Transport. The new liner was named "Eva Perón," in honour of the wife of the President of the Argentine Republic. Apart from some slight modifications to the passenger and cargo spaces, the design and the machinery will be generally similar to that of the "Presidente Perón," already described in our issue of July 22, 1949.

The High Cost of New Ships

IN the course of his speech at the luncheon following the launch of the new Union Castle liner "Bloemfontein Castle," on Thursday, August 25th, Sir Vernon Thomson, Bart., G.B.E., the chairman of the Union Castle line, said that the company wanted other passenger ships, but before placing an order the shipowner had to forecast probable earnings and expenses. A ship had to earn a reasonable return on the capital invested and make a proper contribution for replacement, if the company was to remain solvent. From any forecast that could be made of probable earnings the company found that it was not possible to make that provision on the basis of to-day's prices, and it would have to wait before it could place another order. The vast bulk cost of a passenger vessel was in wages, and in wages embodied in the materials and in the specialists' work coming under that heavy section classed as sub-contracts. The real need, he felt, was for each to produce more week by week. Was that possible, Sir Vernon asked, without increasing the hours in the working week? Had not the time come, he said, to consider some increase in hours, including resumption of the half-day on Saturday, if our country was to dispense with international charity and live as self-respecting citizens? Sir Vernon concluded his remarks by saying that he ventured to make those suggestions as a lifelong friend and believer in the British shipbuilding industry. On the same day, speaking at the launch of the 7500-ton cargo liner the "City of Chicago," at the High Walker Naval Yard of Vickers-Armstrongs, Ltd., Mr. J. M. Ormston, director, made reference to the same subject. He pointed out that in the price of a ship the actual costs of shipbuilders were small and the main charge was made up of products from all over the country. The high cost of ships, he said, was a matter which concerned all industries. He thought that the men in the shipyards were unaware of the true position, and unless they resolved to work harder on full hours, and the trade unions at long last consented to give up restrictive practice, unemployment would follow.

Schofield Travel Scholarships

As a tribute to the long and devoted service of its President, Dr. Herbert Schofield, the Institution of Production Engineers announces the establishment of Schofield Travel Scholarships for graduate members. The scholarships, the first awards of which are to be made next year, will entitle successful graduates to study visits to the U.S.A., lasting for six months and being spent entirely in industry. In succeeding years it is hoped to provide study visits to other countries. All the administrative arrangements will be made by the Institution, and the scholarships will cover travel and subsistence expenses. The objectives which the Institution has kept in mind in establishing this scholarship scheme are to provide facilities for young production engineers to have an opportunity of broadening their outlook and of improving their knowledge of production functions, both technical and managerial; to improve productivity in this country by the implementation and dissemination of the knowledge gained, and to foster a better understanding of the modes of life, social conditions and of the production methods employed in the industries of the U.S.A. or such other countries as may from time to time appear desirable. Two scholarships are to be offered in 1950, covering a six months' period from February to July, but the Council of the Institution reserves the right to make no award if the entries are not considered to be of sufficiently high standard. Graduates entering for the scholarships must have attained their twenty-third birthday, but not have passed their twenty-ninth birthday, on January 1, 1950. Successful candidates will be required to devote all their time in the U.S.A. to studying whatever project they select, and will also be required to read a paper and to report on their particular project in any way which may be considered desirable. Application forms, which must be completed and returned by October 15, 1949, can be obtained from the Institution of Production Engineers, 36, Portman Square, London, W.1.

Junior Iron and Steel Engineers' Meeting

ARRANGEMENTS are being made by the Iron and Steel Engineers' Group of the Iron and Steel Institute and the Plant Engineering Division of the British Iron and Steel Research Association for a meeting of junior engineers to be held at Ashorne Hill, Leamington Spa, on Wednesday and Thursday, October 19th and 20th. The meeting is timed to begin at 4 p.m. on October 19th, when, after tea, there is to be a discussion on "The Repair and Maintenance of Furnaces with special reference to the Planning of Open-Hearth Furnace Rebuilds." The subject will be introduced by a short paper by Mr. S. Huntley, of the Consett Iron Company, Ltd. An evening session at 8.30 p.m. will take the form of an "Accident Brains Trust." On Thursday morning, October 20th, two papers by Mr. C. E. Roebuck, of Steel, Peech and Tozer, Ltd., and Mr. W. G. Mainwaring, of the Steel Company of Wales, Ltd., will form the basis for a discussion on "Planned Maintenance of Mechanical and Electrical Machinery in Iron and Steel Works." Luncheon at 12.15 p.m. will conclude the meeting. The object of this two-day meeting is to provide younger members of the iron and steel and associated industries with an opportunity to discuss engineering problems of interest. Any members of the Iron and Steel Engineers' Group or of the staff of member firms of the B.I.S.R.A., who are below the age of thirty-five, are invited to attend the meeting.

Scottish Industries Exhibition

THE Scottish Industries Exhibition was opened by Her Majesty the Queen at Kelvin Hall, Glasgow, yesterday, September 1st, and will remain open until Saturday, September 17th. This exhibition is stated to be the largest and most comprehensive of its kind to be held in Scotland. Some 330 firms, representing nearly a hundred different branches of industry, are showing their products. Nearly a third of the firms exhibiting are connected with the engineering, shipbuilding and allied industries. Shipbuilding and heavy engineering have long been a feature of Scottish industry, but at this exhibition it is noticeable that light engineering equipment and components are now being manufactured in ever-increasing numbers. Not only are the products of many of the old and well-known firms in Scotland to be seen, but also those of the new branch works of firms in other parts of Britain and of new firms opened since the war years. An interesting representative selection of light engineering equipment is shown in a composite display of twenty-four member firms of the Engineering Industries Association, which now has some 200 members. Also of interest is a stand taken by the Ministry of Supply to show the type and quality of work now being carried out at the Scottish Royal Ordnance Factories. The equipment now being made at these factories is for a wide field of industry and is to particularly high commercial standards. Another Government Department exhibiting is the Department of Scientific and Industrial Research, which is showing on its stand a model of the laboratories being built at Thorntonhall, near the new town of East Kilbride.

Engineering and Marine Exhibition

No. II—(*Continued from page 216, August 26th*)

IN our Supplement and in what follows we continue our description of some of the exhibits at the Engineering and Marine Exhibition, Olympia.

Hancock and Co. (Engineers), Ltd.

The introduction of electronic control for oxygen cutting profiling machines forms the basis of an interesting exhibit shown by Hancock and Co. (Engineers), Ltd., Progress Way, Croydon. For many years this company has manufactured a range of cutting machines capable of producing profiled shapes in steel, using a drawing as a guide for manual operation of the tracer wheel along the desired outline. This profile tracing operation can now be done automatically by an electronically controlled tracer drive whereby the tracer wheel is constrained to follow a path corresponding to the lines of the drawing, causing the cutter to reproduce the same profile as the tracer wheel.

As exhibited (Figs. 9 and 10) the electronic tracer is fitted to a modified longitudinal profiling machine, comprising, briefly, a longitudinal and a transverse carriage, the combined movements of which allow the tracer to cover any part of the drawing table. Essentially, the tracer head, which can be seen in the accompanying illustrations, combines three functions. First, it embodies the electric motor which drives the tracer wheel and the head itself; secondly, this drive is transmitted via the carriage to the cutting head; thirdly, the drive is controlled by a thin beam of light and a photo-electric cell to ensure that the tracer head drive prevents the beam of light from deviating from the line that is being followed on the drawing. The operation of the equipment, which can be considered to combine these three functions, is explained more fully below.

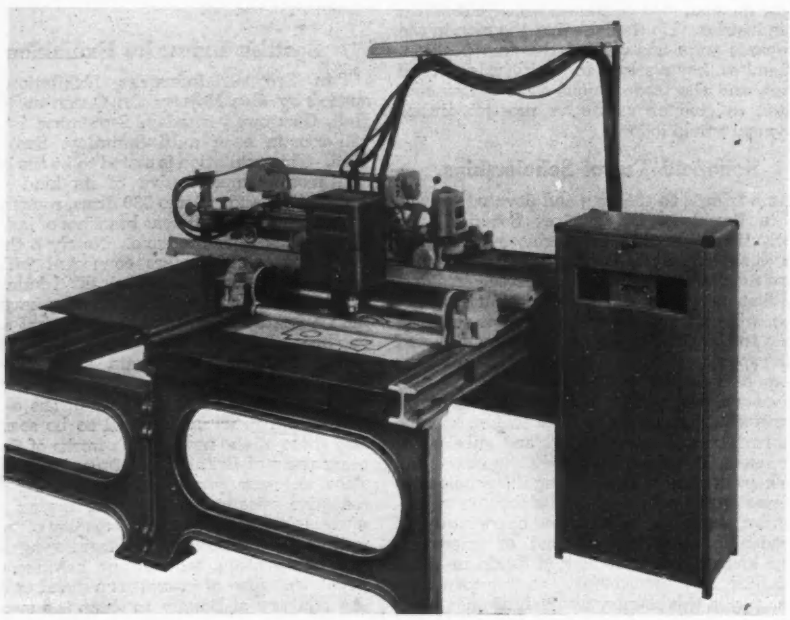


Fig. 9—Electronically Controlled Oxygen Cutting Machine—Hancock

To avoid damage to the drawing the tracer wheel does not rest on the surface of the paper, but (as illustrated) is in contact with the top of a cylinder which is mounted on the main lower carriage parallel to the live axles of the supporting wheels. This cylinder runs the length of the carriage and is geared to a pair of the supporting wheels so that when the cylinder is rotated its peripheral speed corresponds exactly to the speed of the lower carriage relatively to the drawing table.

The axis of the tracer wheel is horizontal, but the whole tracer wheel assembly is carried on a vertical spindle. The action of the driven tracer wheel in contact with the cylinder is simple. When the axis of the wheel is parallel to that of the cylinder the wheel causes the cylinder to rotate and the associated geared drive causes the lower carriage to move exactly as if the wheel were in direct contact with the table. When turned through 90 deg. the tracer wheel runs along the length of the cylinder and causes the top carriage to move along the bottom carriage—again the movement is exactly the same as it would be if the tracer wheel were resting on the drawing itself. In all other orientations of the tracer wheel axis the movement will be a combination of the two components. It follows that the movement of the oxygen burner, which is attached to the top carriage, is rigidly related to the rotation of the tracer wheel and the orientation of its axle.

Operation of the tracer wheel is effected by two motors, one of which drives the wheel itself, while the other rotates the vertical spindle which alters the "steering," i.e., the orientation of the axle. The action of the "steering" motor is controlled by a beam of light and a photo-electric cell.

Briefly, this is achieved by gearing the "steering" spindle to the housing of the projecting lens which throws a narrow beam of light on the drawing board; the gear ratio is 1 : 1, so that the lens housing turns through the same angle as does the tracer wheel steering spindle. Since the beam of light is eccentric with respect to the lens housing, rotation of the housing causes the spot o

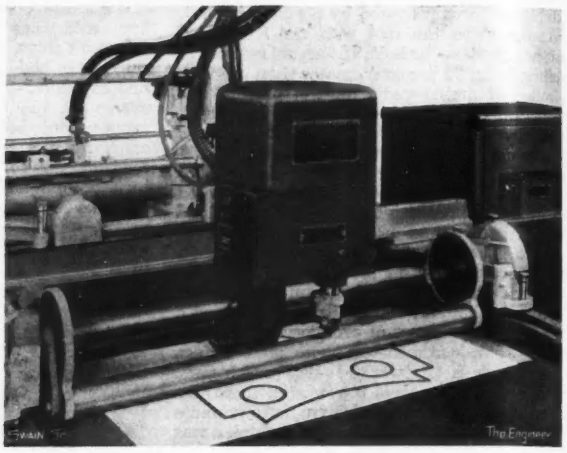


Fig. 10—Electronic Head on Oxygen Cutting Machine—Hancock

light on the drawing to describe a corresponding arc in a circular path. The housing is so mounted, relatively to the tracer wheel, that the spot is in front of the line of travel. Mounted on the side of the beam housing is a photo-electric cell arranged to receive the reflected illumination from the light spot on the drawing. This photo-electric cell forms part of a control circuit which determines the speed and direction of rotation of the steering motor.

The drawing is made with a line about ¼in thick, making an outline corresponding to the profile that is to be cut out. In operation light from the beam is reflected from the paper drawing and when the spot is half over the black and half over the white the amount of reflected light is such that the steering motor remains stationary. Any deviation of the tracer wheel causes the spot to move either more over the black or more over the white, and a signal is immediately sent to the motor which moves the tracer wheel back to the "true" position, the speed depending on the rate of change.

To prevent interference by outside daylight or artificial light, the photo-electric cell is arranged to respond only to the special light of the beam. The speed of the tracer wheel is actuated by a special electrical control to the tracing motor and the speed is governed so that even at acute corners the spot will not deviate from the line being followed on the drawing.

To operate a machine with the electronic tracer drive the travel motor is switched on and the spot of light guided on to the line, the steering motor is started and the electronic control takes over.

The electronically controlled cutting head was designed and manufactured by Metropolitan-Vickers Electrical Company, Ltd., Trafford Park, Manchester.

Stothert and Pitt, Ltd.

Of particular interest amongst the wide selection of pumps and deck machinery made

by Stothert and Pitt, Ltd., of Bath, is a new movable deck crane. This crane is built on the same lines as the firm's standard 1-ton stationary deck crane, but it can be moved from one side of a vessel to the other. It has been introduced to overcome certain of the disadvantages of the practice of installing fixed cranes on both the port and starboard sides of a vessel. With such installations, when a ship is loading or discharging, only the cranes on one side can be used, those on the other side remaining idle. When a ship is fitted with movable cranes it is claimed that the top weight is considerably reduced; cranes can be stowed on the centre line of the ship with their jibs across a hatch to increase the deck space available; initial costs are reduced and maintenance costs are halved.

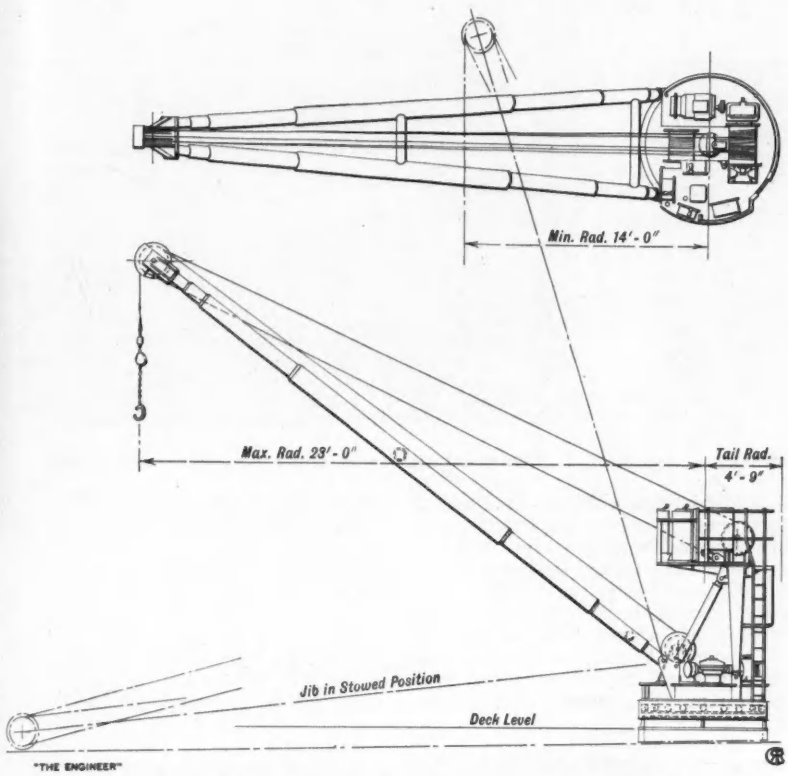


FIG. 11—ELECTRIC DECK CRANE—STOTHERT AND PITT

The new cranes are mounted on four wheels, on which they can be moved by means of block and tackle along runways to required positions on the port and starboard sides of the vessel. The wheels, which can be swivelled so that a crane can be moved athwartship and fore and aft, are made retractable so that once the crane is in position its base can be securely fixed to the deck seatings ready for working.

The general design of a movable crane is similar to that of the fixed crane shown in the drawing reproduced in Fig. 11. Its motions of hoisting, slewing and derricking are each operated by a separate electric motor. The crane has a maximum radius of 22ft and a minimum radius of 7ft 6in, the height of lift above the track being 20ft and the depth of lower below the track 30ft.

Hoisting is effected by a 9 b.h.p., 650 r.p.m. motor, and a weight of 1 ton can be lifted at a speed of 100ft per minute, the light hook speed being 250ft per minute. A single part steel wire rope is coiled upon a cast iron barrel, driven through machine-cut worm gearing connected to the motor through a flexible coupling.

The slewing motion is driven by a 4 b.h.p., 1000 r.p.m. motor through a worm and epicyclic gear and a load of 1 ton can be slewed a a speed of 1½ r.p.m. In this gear the worm wheel is mounted in the sleeve of a sun pinion and planet pinions transmit the motions to a pinion carrier keyed to the vertical worm wheel shaft. The vertical worm wheel shaft rotates in a steel sleeve supported on the superstructure bed-plate.

For derricking purposes the jib is sustained by steel wire ropes coiled on a cast iron barrel having right and left-hand grooves. For this motion power is transmitted by a 6 b.h.p., 650 r.p.m. motor through similar worm and epicyclic gearing to that fitted to the slewing gear. This derricking gear is supported at the apex of the superstructure frame.

The weight of the superstructure is carried on a live ring of rollers and the centre pin is bored for the passage of the power supply cables to the motors. The fabricated base of the crane has at each corner a swivelling bogie fitted with a retractable wheel. The four wheels are designed to run on a level track carried on prepared seatings on the ship's deck. Swing bolts are used to secure the crane to the track when it is in its working or in its stowed position.

The exhibits of deck machinery include a self-contained, contactor-controlled, electrically driven cargo winch. Rotary displacement pumps are shown for a wide range of duties from handling motor spirit to heavy viscosity fluids, such as molasses. Also shown are salt and fresh water pumps for cooling purposes; high-pressure oil pumps, &c.

W. KENNEDY

A recent addition to the well-known range of tube bending machines made by W. Kennedy, of West Drayton, Middlesex, is the small machine shown in Fig. 12.

This machine is intended for bending small tubes and sections such as are used for model making and instrument work. It consists of a cast base, into which is fitted a threaded centre post or mandrel. A top plate is screwed on the mandrel and can be moved up and down on it. A former, shaped to suit the tube or section to be bent, is placed over the mandrel and between the base and top plate.

When work is placed on the machine the top plate is first screwed firmly down on to it and the bending pressure then applied by means of a roller, which is adjustable along the lever arm. The pressure exerted on the work by the top plate makes it possible to bend various sections. The makers state that steel strip, $\frac{5}{8}$in wide by $\frac{1}{16}$in. thick, can be bent on edge to a radius of $\frac{3}{4}$in without any puckering taking place. By use of suitable formers, angles, ties, channels and special sections can also be bent whilst the correct section is maintained.

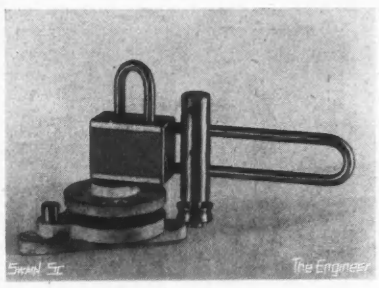


FIG. 12—TUBE BENDING MACHINE—KENNEDY

A representative selection of other types and sizes of bending machines is also being demonstrated on this firm's stand.

F. J. EDWARDS, LTD.

Sheet metal working equipment of all types is to be seen on the stand taken by F. J. Edwards, Ltd., of 359, Euston Road, London, N.W.1. Many of the machines have been described before in these columns, but the universal combination rotary machine, illustrated in Fig. 13, is exhibited for the first time. This machine has a wide range of application and can be used for swaging, wiring, strip and circle cutting, flanging, edging and any other operation where rotary motion of the roll spindles is required. In order that the machine can be set to accommodate the many types of rolls for which it is suited, means of horizontal adjustment are provided for alignment of the rolls. Once the necessary adjustments have been made the shafts can be locked rigidly in their working positions.

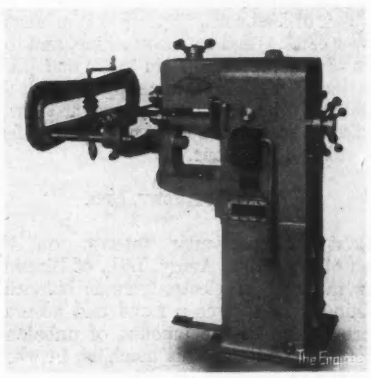


FIG. 13—ROTARY COMBINATION MACHINE—EDWARDS

A 1¾ h.p. electric motor is used to drive the

rolls through a pedal-operated multi-disc clutch and vee belts. The centring device fitted on the machine illustrated can be used to cut discs from 12in to 30in diameter, and it also provides a means for jennying or wiring the edge of discs. For carrying out such operations as crimping and trimming or double operations, such as trimming and bending, special rolls can be readily fitted on the machine.

A compact little machine, known as the "Valjoh," has been introduced by this firm for the quick and automatic turning of such

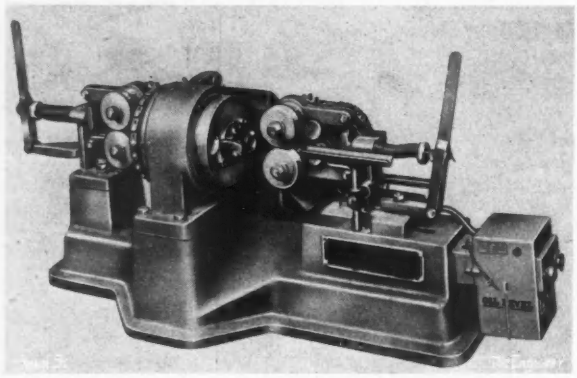


FIG. 14—DOWEL TURNING MACHINE—EDWARDS

things as dowels, broom handles, &c., from timber which would otherwise become waste. This machine (see Fig. 11) is driven by a 2 h.p. electric motor at the rear through vee belts, and its headstock takes interchangeable cutter blocks designed to produce ¼in to 1¾in diameter rounds or shapes.

Material is fed through the headstock by two pairs of pinch rolls, one pair being on each side of the headstock. The pinch rolls are spring loaded and are driven through worm and spur gearing from a common shaft at the rear of the machine. On the feed side timber blanks are placed on an adjustable vee slide leading to the pinch rolls. The pinch rolls are opened by means of a hand lever for the introduction of the timber and on release of this lever the feed is automatic. The pinch rolls at the outgoing side of the headstock pull the remainder of the timber through the cutter block when its end has passed the first pair of feed rolls. Timber in 12in lengths or over can be used on the machine, and four pairs of pinch rollers for ¼in to ⅜in and ⅜in to 1¾in diameter material are supplied with the machine. The machine is designed for a headstock speed of 3000 r.p.m. and a feed rate of 1200ft per hour.

W. AND T. AVERY, LTD.

Plant of particular interest on the stand of W. and T. Avery, Ltd., of Birmingham, includes an electrodynamic balancing machine, which gives a rapid and accurate determination of the amount of unbalance in rotating bodies. This machine, in which the angular location or unbalance is automatically eliminated, is designed for use with rotors weighing from 3oz to 20 lb and up to 16in in diameter. It has been specifically designed for use in production establishments for the rapid and accurate indication of the amount of correction it is necessary to apply at preselected positions on units such as rotors, camshafts, &c. The makers point out that the sensitivity of the machine is of a high order and, although its range is greater than normal commercial requirements, it can be used efficiently by relatively unskilled operators. As the method of determining the unbalance correction required gives an amount to be added or removed from predetermined positions the machine has the advantage that its successful application is not dependent upon the skill of an operator.

The new machine—see Figs. 15 and 16—is self-contained and arranged for bench mounting, no special foundations being required. It consists of a bed on which are mounted two pedestals supporting vertically adjustable vee-shaped bearings, a driving head and an indicator unit. The bearings, which accommodate journals from ⅛ to 1½in diameters, are of plastic material and are suitable for a rotor undergoing test to run directly on the journals or to run in its own bearings. In the driving head a fixed speed motor drives the main spindle through a vee-belt and is normally arranged to drive the test rotor at 1500 r.p.m. A slipping clutch is fitted to limit the torque applied to the test rotor.

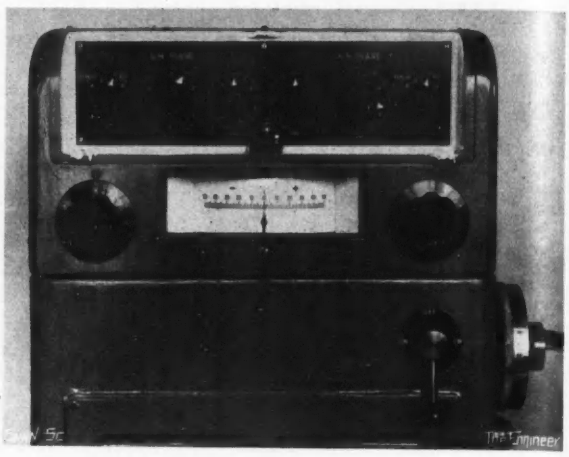


FIG. 16—BALANCING MACHINE INDICATOR UNIT—AVERY

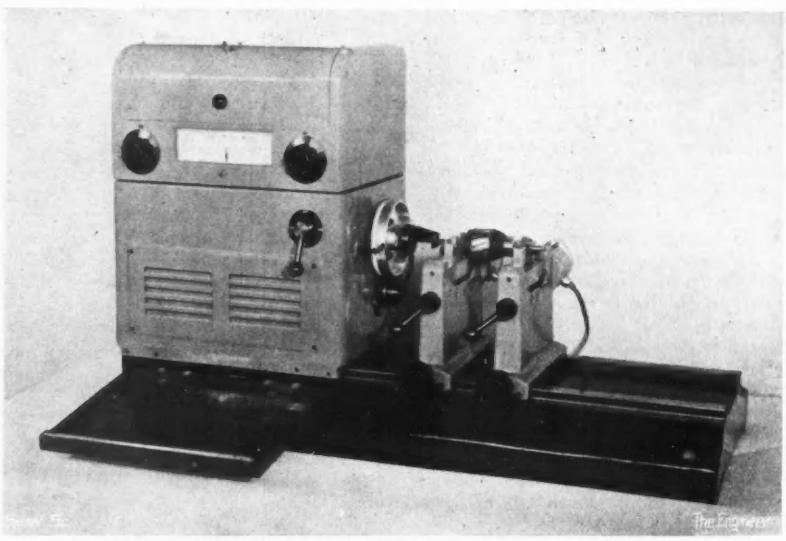


FIG. 15—ELECTRODYNAMIC BALANCING MACHINE—AVERY

The indicator unit (Fig. 16) contains a wattmeter with a central zero and having fifty divisions plus or minus; a four-position switch arranged to give two readings in the left-hand plane and two readings in the right-hand plane of the meter; and a sensitivity control switch, giving full, half and one-fifth sensitivity. Behind a removable panel at the top are two switches and four potentiometers, which are used when setting up the machine.

The machine is of the direct electrical indicating type and its operating speed is above the resonance frequency of the supporting system. Vibrations of the bearings due to unbalance of a rotor undergoing test produce an electric current in moving coil pick-ups on the bearing carriages. This current is compared in the wattmeter with that produced by a phase generator driven from the main spindle. The meter indicates the value of the unbalance in terms of vertical and horizontal components. The vertical and horizontal positions are marked on the driving disc to be seen on the shaft of the machine and the test rotor can be set so that these positions coincide with convenient places for carrying out the correction on the rotor. Although two corrections are required in each plane instead of one, results are given immediately by movement of a switch.

As already stated, the wattmeter is graduated into fifty divisions plus and minus, and in serial balancing a calibration chart can be prepared to convert the readings into the units of correction, such as length of correction wire, number of washers, &c., to be added, or depth and sizes of holes to be drilled to remove material. The machine is so arranged that the addition or removal

of material in one plane does not affect the result on another plane.

The adjustment of the machine to accommodate varying types of rotors, &c., is quickly effected by means of the four potentiometers and two switches on the control panel. These switches also permit the setting of the machine to give the correct sign, plus or minus, according to whether the operation is to add or remove material for correction. When the potentiometers and switches have been set for a particular batch of similar workpieces no further adjustment is required on the part of the operator and this part of the machine can be closed and locked to prevent unwarranted interference.

To prepare the machine for use a suitable driving sleeve is fitted to the end of a test rotor shaft, the pedestals are adjusted to the correct centre distance, and the vee bearings adjusted vertically until the driving coupling and the rotor shaft are horizontal and in one straight line. The driving sleeve can be loosened and the test rotor turned until the "V" (vertical) and "H" (horizontal) marks on the driving disc correspond with selected positions on the rotor. In the case of armatures this is not usually necessary, but with crankshafts it can be arranged so that the points of correction come on the webs or balance weights.

The actual balancing operation consists in moving the four position switch from "L.V." (left vertical) to "L.H." (left horizontal) and then to "R.V." (right vertical) to "R.H." (right horizontal), noting the reading on the wattmeter at each point. The driving motor is then switched off and the test rotor turned by hand to the indicated positions and the requisite amount of material added. The meter indications are linear so that after the first trial a calibration chart can be made to convert the readings into whatever units of adjustment are required.

Towler Brothers (Patents), Ltd.

A new form of axial plunger swash plate pump for hydraulic circuits is being shown for the first time by Towler Brothers (Patents), Ltd., of Rodley, Leeds.

This unit incorporates the well-tried points of the firm's original straight-in-line pump, but it is more compact than the original "Electraulic" pump. It is also able to operate at somewhat higher speeds and pressures, 1500/2000 r.p.m. up to 7000 lb. per square inch continuous pressure, or up to 15,000 lb per square inch momentary pressure for special processes. In the new pump heavily loaded ball and roller bearings are not used and heavy axial thrust loads are carried on film-lubricated thrust washers, which the firm's experience has shown to be virtually free from wear after continuous operation for 2000 hours at 7000 lb per square inch continuous pressure.

In the new pump the plunger ends make direct contact with the swash plate and, being spherical or quasi-conical, provide a maximum radius of contact. To avoid the danger in some circumstances of a lightly loaded plunger "skidding," with consequent scuffing, which would soon destroy the face of the swash plate a bevel gear is interposed between the pump body and the swash plate. This arrangement is designed to ensure positive rolling contact between the plunger ends and the swash plate.

The construction and operation of the new pump can be followed with reference to the sectional photograph we reproduce in Fig. 17.

The driving shaft *A* is a press fit in the swash member *B* and is supported in a lightly loaded roller bearing journal, the sole function of which is to maintain the shaft and swash member in concentric alignment. The swash member has an oblique face and transverse face *C*. The end thrust of the swash member is taken by the film-lubricated thrust washer attached to its transverse face. The wobble plate *D* is mounted on a short journal bearing which maintains concentric alignment between the plate and the swash member. The thrust of the wobble plate is taken by a second film-lubricated thrust washer attached to the oblique face of the swash member. The complete swash plate mechanism is enclosed in a casing at one end of which is the stationary pump body.

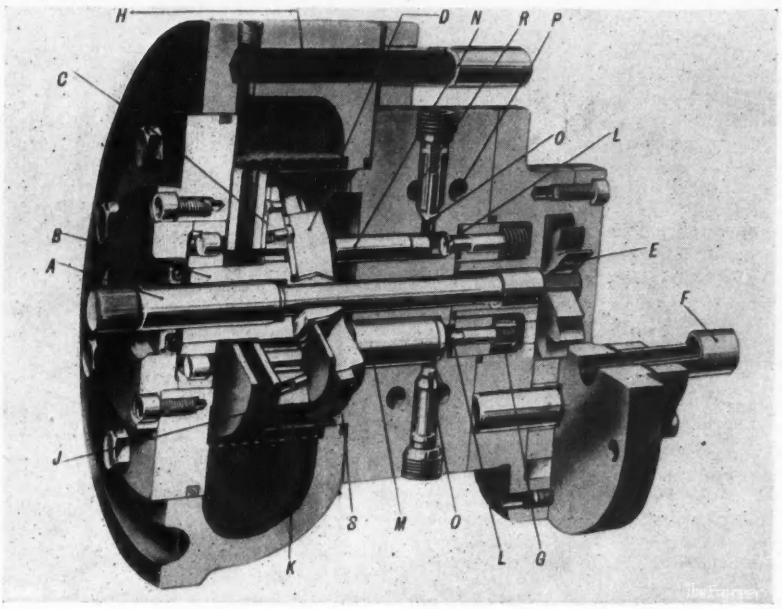


FIG. 17—AXIAL PLUNGER SWASH PLATE PUMP—TOWLER

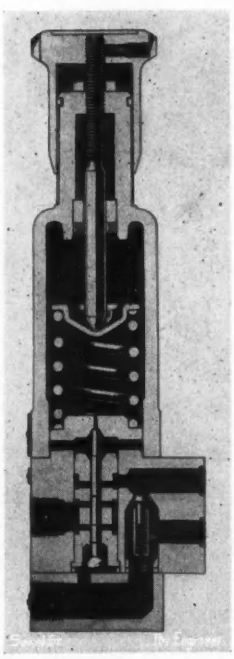


FIG. 18—UNLOADING RELIEF VALVE—TOWLER

A gear type booster pump *E* is driven by flexible shaft forming an extension of the driving shaft. Hydraulic oil from the inlet pipe *F* is driven by the booster pump through a passage to the inlet manifold *G* of the high-pressure pump. The capacity of the booster pump exceeds the capacity of the high-pressure pump and the surplus oil passes along a constricted passage from the inlet manifold into the swash plate casing. The swash plate mechanism is enclosed by a fine mesh screen, which prevents the entry of grit or scale. The surplus oil from the booster pump circulates around the outside of the screen and back through the passage *H* to the pump reservoir, and serves to dissipate any heat generated by the swash plate mechanism.

The oil within the screen is replenished by that which leaks past the pump plungers and although this leakage is minute, it is sufficient to renew the oil within the screen with reasonable frequency during the operation of the pump. Oil to lubricate the swash plate thrust washers enters the swash member by radial holes in the stationary plate *J*, and passes through axial passages to be thrown outwards along radial grooves in each of the washers. A second screen *K*, of large mesh, is provided to prevent swirling, which would interfere with the inward flow of oil to the radial holes.

The constricted passage between the inlet manifold *G* and the swash plate casing ensures that sufficient pressure is built up in the manifold to lift inlet valves *L* and maintain the high-pressure pump plungers in contact with the wobble plate. If the booster pump were to be starved of oil or fail to function, there would be insufficient pressure to lift the inlet valves and the swash plate mechanism would not be loaded. It has been necessary therefore to provide this safeguard in the event of a failure of the oil supply.

The high-pressure pump body contains six axial plungers, three large plungers *M* and three small plungers *N*. Self-acting mushroom inlet valves *L* and discharge valves *O* are situated at the inner end of each pump bore. The inlet valves are in communication with the inlet manifold *G*, the discharge valves of the large plungers with the discharge manifold *P*, and the discharge valves of the small plungers with the delivery manifold *R*.

The plungers protrude from the pump body and their ends make contact with the surface of the wobble plate. The plunger ends are

specially shaped, spherical or quasi-conical, so as to provide a large radius of contact with the surface of the wobble plate, and the contacting surfaces are hardened and superfinished so as to withstand heavy rolling loads. The driving shaft and swash member rotate, whereas the pump body is stationary. The wobble plate is made to rotate very slowly in a reverse direction to the driving shaft by means of a bevel gear *S*, one wheel being attached to the pump body and the other wheel to the wobble plate. The ratio of the bevel gear is as the secant of the tilt angle of the swash member, with the result that the relative reverse rotation of the wobble plate ensures substantially pure rolling contact between the plunger ends and the surface of the wobble plate, the plungers being free to rotate. This geared wobble plate in combination with film-lubricated thrust washers enables the pump to be operated continuously at very high pressures without appreciable wear.

The two discharge manifolds are in communication with a combined unloading relief valve, shown in Fig. 18, which is so designed that, when a predetermined pressure is reached, the larger plungers are unloaded. In this way, the discharge manifold *P* is by-passed to the inlet, and pressure is maintained in the discharge manifold *R* by the non-return valve. When the maximum pressure is reached, the discharge of the small plungers along the manifold *R* blows off at the relief valve.

The combined unloading relief valve can be arranged to operate as a sustained pressure valve, in which case there is only a difference of 200 lb to 300 lb per square inch between the predetermined pressure at which the large plungers are unloaded and the maximum pressure at which pressure is sustained with the discharge of the small plungers blowing off at the relief valve. Alternatively, the valve may be arranged to operate the pump as a two-stage high-pressure pump, in which case there is a difference of 2000 lb or 3000 lb per square inch between the predetermined pressure at which the large plungers are unloaded or by-passed and the maximum pressure at which the small plungers blow off. The booster pump may also be increased in capacity up to 10 g.p.m. at 500 lb per square inch, and provide a low-pressure, rapid-approach stroke for a press ram, with the addition of sustained pressure or two-stage high-pressure for the pressing operation.

The unloading relief valve is adjustable so that the maximum blow-off pressure may be varied at will to suit the pressing operation.

Vickers-Armstrongs, Ltd.

The many-sided activities of Vickers-Armstrongs, Ltd., of Vickers House, Broadway, London, S.W.1, are illustrated on a stand which is larger and more commodious than that of the last exhibition, even if some of the exhibits have been shown before. The principal productions of the firm in shipbuilding, marine engineering, heavy and light engineering, and aircraft construction are illustrated by photographic enlargements. There are also models of the British Clearing press, and variable-speed gears, but the principal machinery exhibits are connected with the equipment produced by the Vickers-Armstrongs firms for the soap, ink, paint, box-making and brewery trades.

Among the section of machines designed for the soap industry there is shown a three-roll toilet soap mill, specially constructed for the manufacture of fine-quality toilet soaps. It has precision ground chilled cast iron rolls, with the pressure attachments necessary to produce a fine ribbon thickness without which "grittiness" in the final product may occur. A toilet soap plodder is also on view and improvements to the machine include a quick-action bayonet coupling for securing the nozzle to the cylinder, improved water cooling and an overload protection device. The design also includes a feed chamber, which eliminates the need for feeding arms or rollers.

Machinery for the ink industry is represented by a triple-roller mill for heavy ink, which will, it is claimed, mill to a superfine finish stiff, viscous inks and pigments in plasticisers for fine qualities of cellulose enamel. In this section a Keenok "Uniroll" mill is displayed with specially designed feeding arrangement, pressure controls and a self-adjusting scraping device, which, it is claimed, increases the output of the mill from 25 to 50 per cent. The Vickers-Armstrongs contribution to the cardboard-box-making and the printing industries is illustrated by several working exhibits, which include the "Empire" 20in wire stitcher for the stitching of cardboard boxes, and the "Empire" pamphlet wire stitching machine. A new machine which we illustrate in Fig. 20 is the book stitcher for the printing trade, which has an unusually high penetrative capacity, and embodies several improvements. It is designed to deal with work with two-sheet thicknesses up to 1¼in at a speed of 160 stitches per minute and will stab thicknesses up to 2¼in.

The machine is so designed that all controls and interchange wire parts are readily accessible to the operator. The table, which is placed at a comfortable height, is made reversible to accommodate either flat or saddle work. The former plates are reversible for four-fold wear, while a large circular knife gives long life, and the bottom cutter block can readily be re-ground. The robust character of the machine is shown by our engraving. The motor drive is placed well within the machine floor space, and thought has been given to the provision of good access to the head mechanism. Ball bearings are fitted to all main shafts and the wearing parts are constructed of special steels.

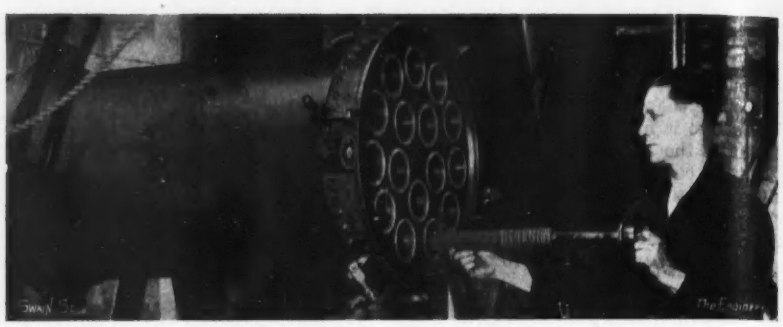


FIG. 19—PRINTERS' ROLLER CASTING MOULD—VICKERS-ARMSTRONGS

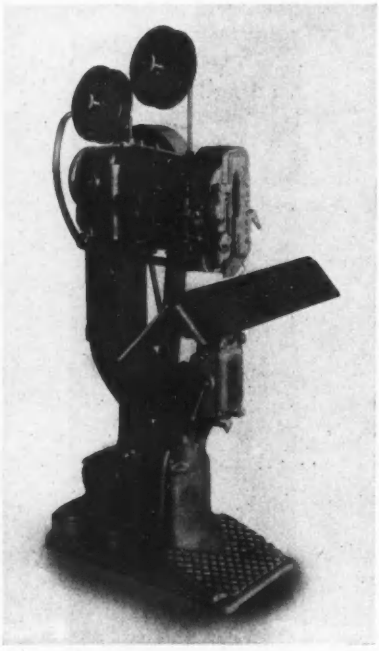


FIG. 20—BOOK STITCHING MACHINE—VICKERS-ARMSTRONGS

Another Vickers-Armstrongs development concerns the casting of printers' rollers, a technique which requires a high degree of precision, particularly in the making of moulds which must be perfectly aligned and have a flawless surface if rollers with a high-quality surface are to be produced. The complete equipment includes a forcing kettle in which the covering composition is heated and provision for the moulds, which may have diameters from 2¼in up to 6in, and lengths up to 104in, to be filled in a cylinder in groups of twenty. We show in Fig. 19 such a cylinder being loaded by assembling within it the roller stocks in preparation for the casting process. Where single moulds are necessary special pedestals are used in which the covering composition is forced up from the bottom of the moulds. The design eliminates the disadvantages of the older way of pouring from the top. Such single moulds can be supplied with or without water jackets for heating and cooling, and examples of these moulds are to be seen on the stand.

Brief mention may be made of the variable-speed gear exhibit, which includes "VSG" variable delivery or pressure pumps. This gear is a development of the Williams-Janney gear, and a model is shown to illustrate the pump unit connected to hydraulic motors. Not only has this principle been largely adopted for ship's steering gears, but it has also been successfully employed in a wide range of industrial applications.

Examples of the Vickers "Pyramid" hardness testing machine are shown, in which a diamond of pyramidal shape applies the desired load without shock, and the resulting impressing is accurately measured by a microscope, having adjustable knife-edge shutters, and a recording counter which gives the Vickers hardness number.

A prominent exhibit on the Vickers-Armstrongs stand is again the "Super-Forty" bottling machine, designed and built by G. J. Worssam and Son, Ltd., of Tottenham, London, N.1, a firm

specialises in machinery for the brewing industry. In this machine the bottles are automatically filled and crowned. The filling is dripless, and the filling level can be altered while the machine is running. Provision is made for rinsing the machine out with scalding water, and sterilising it with steam. It is claimed that this machine is capable of bottling beer without fobbing or the loss of beer or CO_2 and to precision filling levels.

Finally, a representative group of metal office furniture produced by the Dartford Powder Mill Lane Works is on view.

H. Widdop and Co., Ltd.

The principal exhibit on the stand of H. Widdop and Co., Ltd., of Greengate, Keighley, and 14, Stanhope Gate, London, W.1, is a four-cylinder, two-stroke, heavy-duty, direct-reversing marine oil engine with pressure charging by an engine-driven blower. This engine, which we illustrate in Fig. 21, has a designed output of 200 b.h.p. when running at a speed of 440 r.p.m. or 220 b.h.p. at 450 r.p.m. It has a cylinder bore of 8½in and a stroke of 13½in, and is the smallest of a range of three engines with four, five and six cylinders, respectively, forming the firm's "EMB" range, embracing powers from 200 to 300 b.h.p. at 400 r.p.m. to 220 to 330 b.h.p. at 450 r.p.m.

As may be gathered from our engraving, the baseplate forms a continuous casting, which houses the main bearings and also the thrust bearing.

The crankcase is of box-section and carries large inspection doors, which are designed to give good access to the running parts. A solid forged crankshaft of steel is supported in heavy white-metal lined bearings, which have been specially arranged for easy inspection and removal for examination. A bronze bottom end of marine design

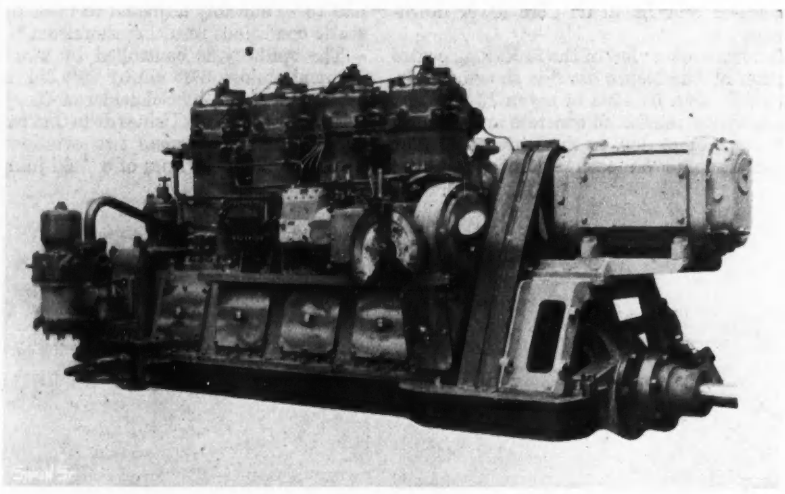


Fig. 21—220 B.H.P. Marine Oil Engine—Widdop

is fitted to the forged steel connecting rods. The pistons are made of special cast iron and are finished by precision grinding. A camshaft driven by chain from the main crankshaft is carried in ball and roller bearings and a centrifugal pattern governor is designed to retain control of the engine at all running speeds.

For starting, an engine driven air compressor is provided, and is supplied complete with air storage vessels.

The fuel pumps and injectors fitted to the engine are of C.A.V. or other proprietary makes. It will be noted that the chain-driven blower is mounted on a bracket at the end of the engine.

All manoeuvring controls can be carried out by the movement of a single hand lever and if desired the engine control can be extended to the steering position on a vessel. The clutch between the engine and propeller shaft is of a metal-to-metal expanding type and is operated by means of compressed air.

The engine is lubricated by positive plunger oil pumps and a duplex filter and oil cooler is provided. The cooling water and bilge plunger pumps are run at half engine speed and have gun-metal fittings. The bilge pump is inter-connected with the circulating water pump for use in an emergency.

The drive for the engine auxiliaries is transmitted through reduction gearing and is furnished with pressure lubrication. The engines we have described are designed to work on standard diesel engine oil fuels and built to the requirements of the Board of Trade and Lloyd's Register of Shipping and other classification societies.

Other exhibits on the Widdop stand include two units of the firm's "EMX" range—a twin-cylinder 60 b.h.p. engine and a 180 b.h.p. six-cylinder engine. A smaller engine is the "SW" single-cylinder diesel engine for auxiliary service, which has a bore of 4in and a stroke of 4in and a designed output of 6 b.h.p.

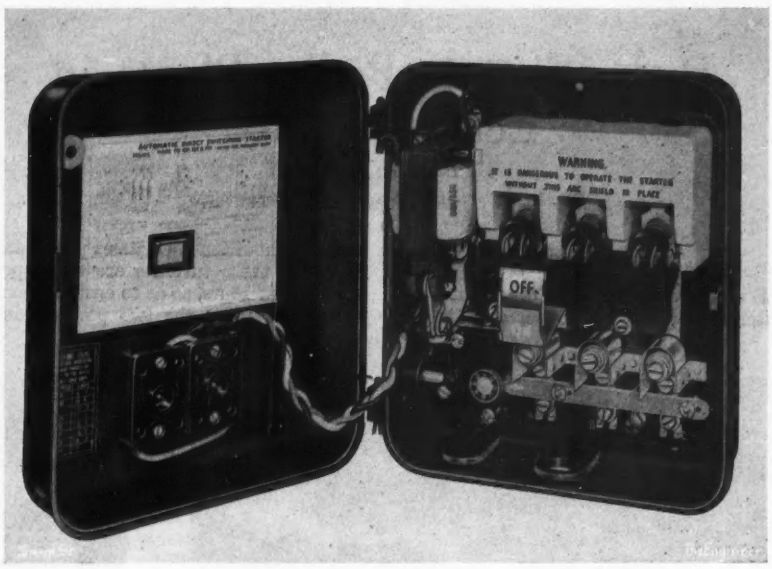


Fig. 22—Automatic Direct Switching Starter—Brook Motors

Brook Motors, Ltd.

Modern practice in control gear for small electric motors is well exemplified in the "ZT3" automatic direct-switching starter exhibited by Brook Motors, Ltd., Huddersfield.

A view of the starter with the cover open is reproduced herewith to show the general arrangement of the equipment. It consists, essentially, of a triple-pole magnetically operated contactor with overload and low-voltage protection, "on-off" signal indicator and "start" and "stop" push buttons. The panel carrying this apparatus is resiliently mounted and totally enclosed in a die-cast case fitted with hinged cover and arranged for wall mounting; alternatively there is a flush-fitting cavity mounting suitable for use with machine tools.

All phases are provided with thermal overload protection with inherent time lag, calibrated to trip on 400 per cent overload in ten to twenty-five seconds, on 50 per cent overload in one to two minutes, and on 20 per cent overload in thirty to sixty minutes. A continuous overload of 5 per cent can be sustained without operating the thermal trips. For resetting the thermal protection after tripping there is an external knob conveniently placed on the side of the case. The plunger that is actuated by this reset knob can be seen projecting through a boss on the bottom left-hand side of the casing.

The contactor is fitted with easily renewable spring-loaded contact fingers which are copper or silver-faced. Auxiliary contacts are fitted with silver points, and all metal parts are fully plated. The terminals are readily accessible and are mounted close to the cable entries, which have clearance holes for 1in conduit.

Our illustration, Fig. 22, shows the push-button switches mounted on the inside of the hinged cover. The push-buttons themselves are clearly marked on the front of the cover, and the "stop" button is fitted with a prominent mushroom head to ensure speedy

and positive operation in emergencies. Remote or automatic control from limit switches or other similar devices can readily be arranged, and for this purpose, separate push-button stations can be supplied.

The starter is suitable for single-phase, two-phase or three-phase supply and is rated for 40 starts per hour, the maximum current being 17·5A on 440V, and 24A on 200V.

(To be continued)

Hydro-Electric Power Plants in Central France

By Dipl.-Ing. C. CARTY

No. III—*(Continued from page 221, August 26th.)*

The Cere River

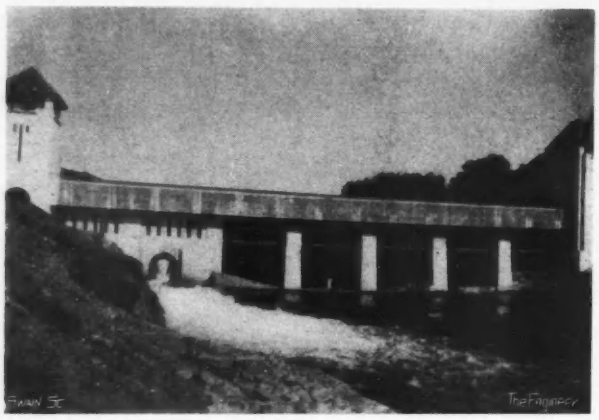
THE upper reaches of the Cère, a left bank tributary of the Dordogne, are entirely situated within the Cantal Department. The hydro-electric development of this river was started in 1927, when concessions were granted for power stations at Lamativie and Laval de Cère, which operate under heads of 492ft and 360ft respectively. As these two stations have no reservoirs they were subject to any variation in the flow of the river which might occur. This deficiency has been remedied by the installations of Saint-Etienne-Cantalès, placed into service in 1945 and comprising, in addition to the dam and power station of that name, the smaller dam at Nèpes with an equalising reservoir. Situated 1½ miles downstream from the main plant, this compensating reservoir regulates the outflow from the turbines at the Saint-Etienne-Cantalès power station. Generally these turbines are only operated during peak hours, so as to ensure a constant volume flow for the two power plants at Lamativie and Laval de Cère lower downstream.

A downstream view of the 230ft long centre portion of the Nèpes dam[6] is shown in Fig. 24. This dam consists of seven 15¾in thick semi-circular reinforced concrete arches, built at a slope of 45 deg. to the horizontal. The end abutments on each side of this centre portion are themselves connected with the river bank by concrete core earth fill dams. Fig. 25 shows an upstream view of the right-hand earth dam and abutment.

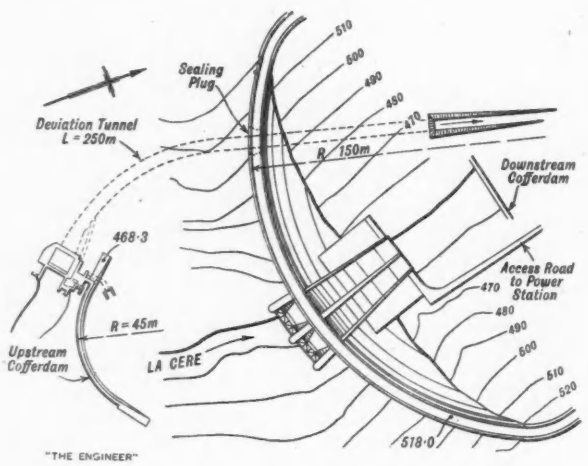
The dam of Saint-Etienne-Cantalès is of the "gravity-arch" type.[7] It is 230ft. high, 115ft thick at the base, and 18ft. thick below the crest, over which runs a road 886ft long. The concrete volume of the dam is 163,000 cubic yards. A plan and section of the dam are shown in Fig. 26.

The volume of the reservoir is 130,000,000 cubic metres, of which 100,000,000 cubic metres are available for power production. It extends over a length of 8¾ miles and covers an area of 2½ square miles. The maximum level is fixed at 517m by the Ribeyrès viaduct, over which the railway from Aurillac to Figeac crosses the Cère, about 3¾ miles upstream from the dam. This single-track viaduct has a length of 1017ft and is carried on iron trestles at a maximum height of 180ft above the valley. As these trestles are now entirely surrounded by the waters of the reservoir, they had to be encased with concrete. This, in turn, stiffened the trestle piers, so that the decking supports had to be suitably adjusted to meet the new static conditions resulting therefrom.[8]

The spillway is controlled by two radial segment sluices, 37ft 9in by 25ft 3in in cross section, supplied by Schneider et Cie. jointly with the Société des Usines de la Chaléassière[9] (Fig. 28). It comprises two overflow races arranged along the lines of a "ski-jump" on the downstream face of the dam and over the roof of the power station, which is just below the dam and is protected by a reinforced concrete slab, nearly 10ft thick. This arrangement resembles, to a certain extent, the masonry sheds protecting roads and railways



FIGS. 24 AND 25—NEPES DAM



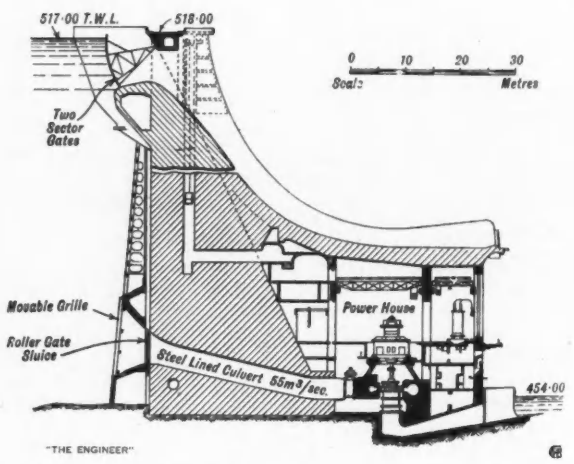


FIG. 26—PLAN AND SECTION OF ST. ETIENNE-CANTALES DAM

[6] E. Parisot: Le barrage et l'Usine génératrice de Saint-Etienne Cantalès. *Revue générale de l'Electricité*, Septembre, 1946, t. LV, pages 335–358. See also THE ENGINEER, Vol. 180, page 140.

[7] *Loc. cit.*

[8] *Loc. cit.*

[9] *Loc. cit.*

in the Alps and in Norway against avalanches of snow, or against the devastations wrought by the mud and debris carried by mountain torrents when in flood. The overflow is thus discharged in two jets, which meet in the air at a certain distance downstream from the power station. When they fall down into the river bed, a portion of their energy is thus dissipated. During the construction of the Saint-Etienne-Cantalès power plant, this

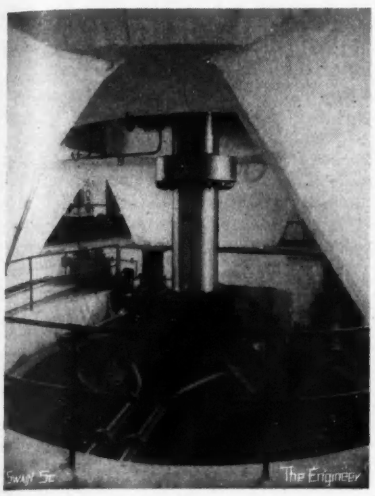


FIG. 27—SUPPORT FOR ALTERNATOR

"ski-jump" allowed a heavy flood to be discharged over the roof of the power station without any damage to the latter.[10]

THE SAINT-ETIENNE-CANTALES POWER STATION

The power station will be provided with three turbo-alternator sets when in full operation, two of which are at present in service. Each of the three conduits through the dam has a diameter of 13ft $7^{11}/_{32}$in, and a length of 121ft $4\frac{3}{4}$in to the turbine main valves. The main turbines are of Francis type with vertical shafts, and are designed for a speed of 214 r.p.m., and for a head varying between 203ft and 115ft. Their output varies between 39,200 h.p. and 15,700 h.p. and

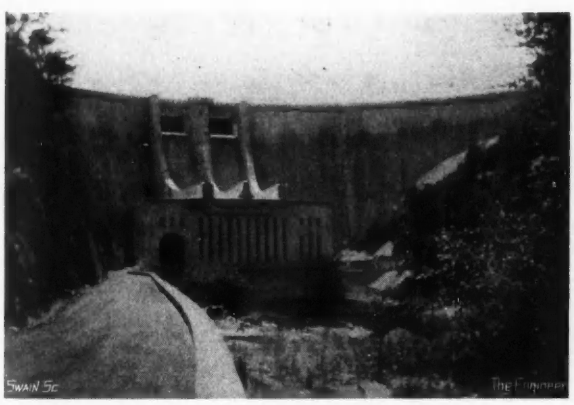


FIG. 28—ST. ETIENNE-CANTALES DAM

they were supplied by Als-Thom Charmilles.[11] Because of the extreme softness of the waters of the Cère, the turbine blades are particularly subject to cavitation troubles. One of the methods adopted to meet this difficulty has been to supply air under pressure at the turbine centre, but the results obtained have not been fully satisfactory. The alternators have an output of 30,000kVA at 12kV.

The top end of each turbo-alternator shaft carries one main exciter having an output of 150/600kW at 200V, with separate excitation at 110V. It also carries one governor exciter with compound excitation of 3kW output at 110V, and one governor alternator of 2kVA output at 220V, 50 cycles, for the power supply of the motor operating the turbine governor.[12]

The supports of the alternator set are so arranged as to transmit their thrusts to a pentagonal concrete foundation block shaped as an open frustum of a cone (Fig. 27).

The auxiliary set is also a Francis turbine, but with a horizontal shaft; it was manufactured by the same firm as the main sets. This auxiliary turbine has an effective output of 412 h.p. and is supplied through a 1ft $11\frac{5}{8}$in pipe, which acts as a by-pass for the three main conduits.[13] The auxiliary alternator has an output of 375kVA at 5·5kV and was also manufactured by Als-Thom.

On the right bank of the Cère and about 65ft above the dam, the Gatellier transformer station has been erected (Fig. 29). The power output of the plants at Lamativie and Laval de Cère is brought in by a special 90-kV transmission line, and is here stepped up to a voltage of 220kV. The station provides a similar transformation for the power produced at Saint-Etienne-Cantalès.

After a detailed study of the possibilities, it was decided that the power produced by the alternators in the Saint-Etienne-Cantalès plant, at a tension of 12kV, should be stepped up within that plant to 90kV, and then transmitted by two standard overhead transmission lines from the power station to the Gatellier, where the voltage is stepped up again to 220kV. In order to reduce the necessary earthworks, the outdoor equipment of this transformer station has been installed at four different levels. The lowest level is

FIG. 29—ST. ETIENNE-CANTALES DAM AND TRANSFORMER STATION

that for the incoming 90-kV lines from the different power stations. The next level carries the 90-kV circuit breakers supplied by the Ateliers de Constructions de Delles, and the concrete cells for the 90/220-kV transformers. On the third level are the 220-kV circuit breakers, and on the fourth and highest level there is a double set of 220-kV bus-bars.

(To be continued)

[10] *Loc. cit.*
[11] *Loc. cit.*
[12] *Loc. cit.*
[13] *Loc. cit.*

Umkomaas River Bridge

A NEW bridge, constructed over the Umkomaas River on the Natal South Coast line, is of reinforced concrete. It is 730ft long, and, with a total deck width of 60ft 6in, is wide enough to accommodate two railway lines, as well as a broad roadway and two generous footpaths. The railway portion of the deck is 28ft 3in wide, whilst the road is 22ft. The two pedestrian walks occupy a width of 10ft 3in. The bridge consists of nine concrete spans with piers at 81ft centre to centre, the spans being of the simply supported tee-beam type, each 75ft in length. It is stated that there are probably not many bridges of similar construction and span length carrying railway traffic. Owing to their long span the deck beams are of considerable depth and steps had to be taken in the design to minimise the impression of a large staring concrete surface. The deck was arranged to overhang the outer beams to a degree that would throw a fairly wide horizontal shadow on the beam faces during the greater part of the day. Further, to prevent adding to the depth of solid concrete at any point, the deck parapets were specially designed to give a light, airy appearance. This effect was obtained by using slender pre-cast balusters, which were placed in position and cast in with the deck. There were many construction difficulties. The deck is supported by solid concrete piers carried by reinforced concrete cylinders sunk to rock, and the sinking of these cylinders to form a true and firm foundation on the rock of the river bed presented no mean task. The bridge spans the river practically at its mouth and high tides and heavy seas severely hampered the progress of the work, often battering to destruction temporary structures that had taken weeks to complete. Material used included 16,400 cubic yards of concrete and 930 tons of reinforcing steel.

Air Survey in Relation to Civil Engineering

By ROLT HAMMOND, A.C.G.I., A.M.I.C.E.

AIR survey originated in World War I, when it was used for disclosing camouflaged enemy positions, and from this beginning it was soon found that accurate line maps could be produced if pairs of air photographs were taken so that there was a 60 per cent overlap longitudinally to allow stereoscopic examination. Accuracy of such maps is largely determined by the ground control provided by conventional ground surveying methods.

Ground photographic surveying dates back to 1851, when Laussedat of the French Army began experiments and produced a map of a village near Versailles; the Brunner photo-theodolite was introduced in 1859, and further experimental work resulted in the evolution of the Zeiss photo-theodolite of 1906 in Germany. In 1888 Captain Deville, Surveyor-General to the Dominion Lands, Canada, carried out surveys from ground photographs in the inaccessible parts of the Rocky Mountains; the United States undertook similar work in Alaska when that territory was transferred to them by Canada. In 1890 plans for the Jungfrau Railway in Switzerland were prepared by ground photogrammetry, much of the route passing through mountainous country so rugged and precipitous that it would have been impossible to use any other method of survey. Thereafter a number of surveys was carried out, but in this country photographic surveying was not possible on a large scale owing to climatic conditions. Ground photogrammetry formed the essential background for the development of air survey, because much of the equipment used in this technique has originated from ground photo-surveying. The first outstanding technical advance in instruments was the introduction by Fourcade in 1902 of the stereocomparator, made by Carl Zeiss, of Jena; in this apparatus adjacent pairs of photographs were examined stereoscopically, measurements being based on the "difference of parallax," a measurement of the relative displacements of points appearing in two photographs. In 1907 Major F. V. Thompson, R.E., of the British War Office, introduced a mechanism known as a "parallax drum," with which distances could be read without computation; he also added a simple lever for plotting. His apparatus was used experimentally for a survey of Fiji in 1908–10, but the first machine to provide automatic plotting from air photographs was the Von-Orel stereoautograph of 1908.

Laussedat, to whom we have already referred, carried out the first air survey in 1858, the photographs being taken from captive balloons or kites; in 1881 Woodbury, an Englishman, used panoramic views taken from balloons for survey purposes. Modern air survey is largely based on the Arundel method, due to the pioneering work of Brigadier M. Hotine, R.E., C.B.E., at present Director of Colonial Surveys. The first experiments were made in 1925, when many difficulties were encountered; in the Report issued by the Ordnance Survey in 1927 it is stated: "Delays and wasted flights were caused by defects in the sights, films and other equipment, and were in no way due to the contractors, the Aircraft Operating Company, Ltd., though the extra expense caused thereby had unfortunately to be borne by them. The first films were almost ruined by static markings . . ."

Developments in the new technique proceeded in the United States, and in 1929 McKinley* wrote: "In the single decade since the World War, aerial photography has progressed from crude rule-of-thumb work to that of a science. Cameras and instruments are improved to a degree which at last makes accurate work possible . . . In mapping inaccessible territory, the aerial survey has already assumed priority as shown by the success of the Hamilton-Rice Expedition in mapping hitherto inaccessible regions in tropical South America . . Considering the map as a representation of detail on the earth's surface, the aerial camera records these details in a manner impossible to obtain by any other method . . . Air survey has justified its existence as a surveying method by its two outstanding factors, namely, speed and recording of detail." This may be taken as a fair statement of the present position of air survey in relation to civil engineering.

WILLIAMSON ORDNANCE SURVEY CAMERA

DRIFT SIGHT AND CAMERA CONTROLS

In recent years many successful air surveys have been carried out in the United States of sites for dams and reservoirs, two of which are referred to by Professor C. A. Hart in his standard work on this subject†. Perhaps the most outstanding achievement was a contoured map of the Boulder reservoir made under contract by the Fairchild Company. This map was used for determining the rate of silting in Lake Mead and is a topographic map to a scale of 1 in 12,000 with contours at a vertical interval of 10ft; it was produced from a Zeiss stereoplanigraph from vertical air photographs. Control of levels and triangulation points was provided by the United States Coast and Geodetic Survey, the contours being taken to a height of 170ft above top water level of the reservoir. Interesting proof of accuracy was provided by this work; after the sluice gates at Boulder Dam had been closed in 1935, the rising water line was photographed at contour intervals of 20ft, when it was found that the contour lines on these photographs agreed closely with the photogrammetric contours determined by the original air survey.

Similar work was undertaken by the same contractors for the site of a dam at San Gabriel for the Los Angeles County Flood Control District. In a letter to Messrs. Fairchilds, Mr. E. C. Eaton, the Chief Engineer, wrote: "In checking your map we had available two independent contour maps . . . These maps were compiled from approximately 1000 points per acre, which were established by precise triangulation and levelling. The quantities computed . . . from your map varied less than one-tenth of one per cent from the mean of the other two maps. We consider your map to be of at least equal accuracy to our surveys; you accomplished the work quicker than would be possible by ordinary methods; and your charge was considerably less than the cost of a similar map of this territory produced by ground methods."

Again, in Africa, the Aircraft Operating Company of Africa carried out an air survey in Northern Rhodesia for a complete water power development in broken and thickly wooded country. Using ground survey methods, many months of costly and tedious reconnaissance would have been necessary, but all this was avoided, the best route for pipe-lines and the best sites for dam and power-house being determined by a detailed study of the air photographs. Having selected the route, the ground surveyors merely took levels and ran a traverse along it.

These examples provide ample evidence of the usefulness and economy of air survey in the reconnaissance of railways, roads and other schemes in undeveloped country or in localities where the terrain is broken and rugged. There are also cases, for instance in railway engineering, where it is inconvenient, and sometimes quite impossible to carry out a ground survey of a busy junction or terminus. An example of the value of air survey in this field was provided by the large scale air survey carried out by Hunting Aerosurveys, Ltd., of Bournemouth Central Station on behalf of British Railways, Southern Region. The aircraft flew at a ground clearance of 1600ft, in order to obtain the necessary detail to provide a

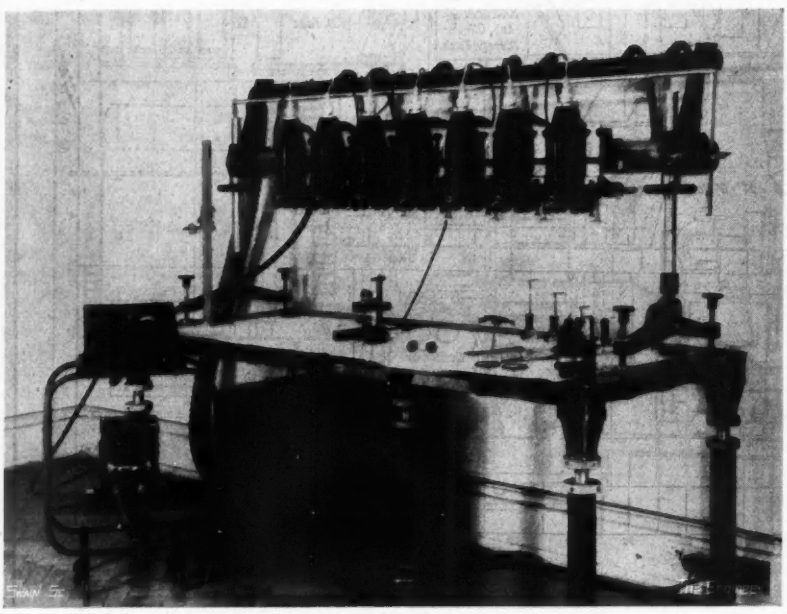
* "Applied Aerial Photography," by A. C. McKinley, New York, 1929.

† "Air Photography Applied to Surveying," by C. A. Hart, M.Sc. (Eng.), Ph.D., Longmans Green and Co., London, 1943.

plan to a scale of 1 in 480. Here, individual details stood out so clearly that it was possible to place the tracing dot of the stereoplotter on the centre of each rail of every track. This provided an accurate picture of each line, and any lack of smoothness on curves would at once have been revealed.

Air Survey Equipment

The very high precision of modern photogrammetric plotting machines opens up an entirely new field in air survey mapping of outstanding importance to the civil engineer; contour plans up to a scale of 1 in 1250 can be produced with a minimum of ground control, and to a uniform accuracy seldom attainable by ground methods. Time taken for completion of an air survey is normally less than would be required for carrying out the same work on the ground. Moreover, measurements taken from the air photographs can be checked without revisiting the ground, while the clear-cut stereoscopic views provided enable a thorough study to be made in relief of types of vegetation, geological structure and other essential information.



Williamson-Ross "Multiplex" Mapping Equipment

The Williamson ordnance survey camera installed in an "Anson" aircraft is shown in an accompanying illustration. The mounting is of gymbal type, and the complete assembly can be rapidly levelled by a vertical handle bolted to the top of the Perspex dome; when in flight, the axis of the camera is aligned to the angle of drift by the graduated protractor visible in the foreground. This angle of drift is determined by a sighting vane, or by the drift sight which is conveniently placed at the camera operator's feet. A drift sight fitted in a de Havilland "Dove" survey aircraft is also illustrated.

Since the requirements of air survey work vary considerably, it is not possible to have a standard type of survey aircraft; the choice generally falls on a small and economical civil type which has the speed, range, payload and endurance required for air survey, and which can operate under very difficult conditions without an elaborate ground organisation. An air survey aircraft must be reliable, stable and free from vibration; furthermore, the crew must not be cramped or restricted in any way, and there must be direct and rapid communication between camera operator and pilot. Since much air survey work is done with extreme wide-angle lenses of short focus the camera must be low in the floor and have a field of view unobstructed by parts of the aircraft.

Survey aircraft can be controlled accurately on their course by an automatic pilot, but careful adjustment is needed to reduce lateral tilt to the minimum possible amount. The Sperry gyropilot is claimed to be an excellent instrument for this work.

The Williamson ordnance survey camera Mark III has been fittingly described as an aerial theodolite. Its magazine is driven by a separate motor, and it has a capacity of 500 9in by 9in exposures, thus permitting a full day's work to be done without changing magazines. Principal instrument readings are recorded on the film, such as those of the altimeter, spirit level, watch and counter. Four lenses may be fitted, namely, 6in wide-angle, 8¼in, 12in and 25in. The camera mounting in the de Havilland "Dove" has been specially developed for aircraft which have cabin heating; it permits 20 deg. of fore-and-aft tilt adjustment in flight, and 15 deg. of lateral tilt adjustment. The camera is operated by the remote motorised control shown in our illustration. A signal lamp fitted in front of the pilot is connected to the camera control box and gives warning five seconds before a photograph is to be taken; the pilot is thus relieved of the continuous concentration of maintaining level flight between exposures.

When contours are not required on the finished map and the ground relief is less than ten per cent of the altitude of the aircraft, detail mapping can be carried out semi-graphically with the aid of a special enlarger. Space plotters must be used, however, for contouring, or for mapping rugged areas.

The "Multiplex" space-plotter, which is one of the simpler types, is shown in an illustration. Glass miniatures of air photographs are fitted into each of the projectors shown, which can each be rotated into the position of the taking camera. The images of alternate pictures are projected in red and blue by means of colour filters, and when viewed through coloured spectacles of complementary colours one picture is seen by each eye and a stereoscopic image is thus obtained. The whole strip is first adjusted in correct relationship so that perfect fusion is obtained over the whole area and plotting is then carried out with a small movable table. This tracing table is mounted on a horseshoe stand and contains a small illuminated hole at its centre which appears as a floating point of light on the stereoscopic image. The height of the tracing table can be adjusted by a micrometer, and the spot of light made to move so that it appears just to touch the ground and thus to trace out the line of the contour to which it is set; the contour is simultaneously drawn on the map by a pencil point. More accurate instruments, which operate on the same basic principles, such as the Wild stereo-autograph, are generally used for large scale plotting.

Future Developments

The second World War gave a tremendous impulse to the progress of air survey, the production of military maps being of great importance; between 1942 and 1944 about 700 different map sheets at a scale of 1 in 25,000 of northern and western France were produced.

A description of this work has been given by Professor C. A. Hart, T.D., M.Sc.,‡ who has stated that air survey photography is now accepted as essential for projects of any size up to scales of about 1 in 10,000, since only by this means can mapping be ahead of economic development. He stresses the fact that photogrammetry provides a means of topographical surveying, to be used in conjunction with other methods, but not to their exclusion; this cannot be stated too often.

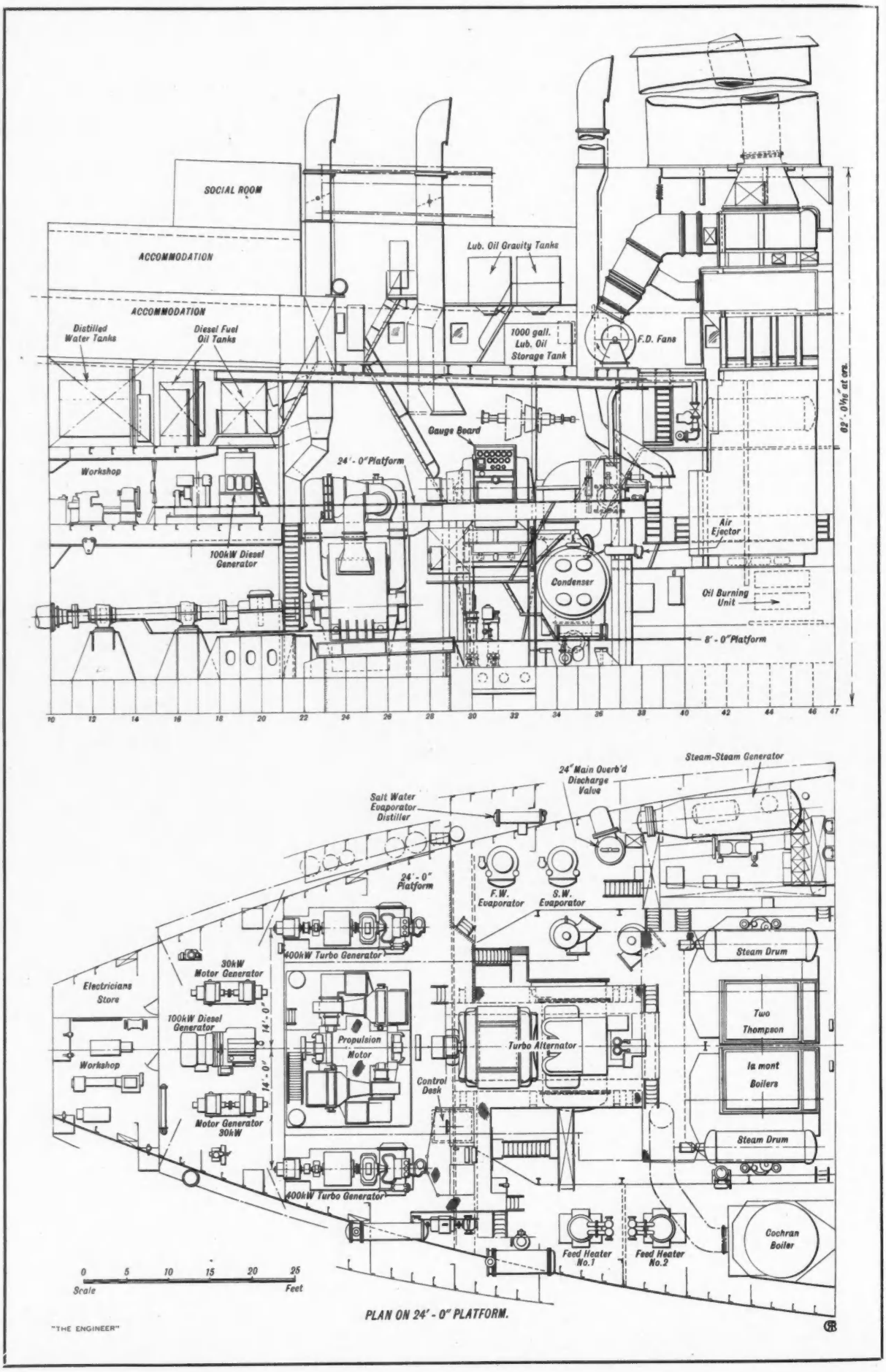
The experimental work carried out during the war proved that contoured maps to a scale of 1 in 25,000 could be prepared from air photographs taken during stabilised flight, using radar fixation and accurate differential altimetry; Professor Hart states that such a survey will have the same accuracy as that obtained by ordinary survey methods but referred to an approximate datum. The latter is not produced with reference to the ground, other than that provided by remote radar stations up to 200–250 miles away.

In referring to possible developments in peacetime air survey, Professor Hart points out that the economic balance between photogrammetry, ground survey and radar control has not yet been established, and that it cannot be assessed by comparison of costs for survey alone. By employing radar-navigated photography, he writes, the surveyor will be able to position such ground control as is required in a small fraction of the time needed for full ground control. He believes that with such an instrument as the Wild autograph A5, it is possible to apply large scale photography to accurate mapping up to a scale of 1 in 1000, with contours to a vertical interval of about 1m. This scale limit agrees with the views of air survey experts with whom the author has discussed this matter.

Professor Hart anticipates that the next important step forward in air survey technique will be the employment of helicopters and short-range radar or radio measurement; high-frequency pulse radar or low-frequency continuous wave may have a range up to 20 to 30 miles or perhaps 40 to 50 miles, with

‡ "Some War-Time Applications of Air Survey, Including the Employment of Radar for Remote Control, and their Effect on Survey and Photogrammetry in Peace," a paper by Professor C. A. Hart, A.M.I.C.E., in the Symposium of papers on War-time Engineering Problems, Inst. C.E.

MACHINERY ARRANGEMENT OF TURBO-ELECTRIC TANKER "SAN SILVESTRE"



PLAN ON 24'-0" PLATFORM.

accuracies ranging from plus or minus 2 to 3m. He imagines such an apparatus fitted in a helicopter, capable of hovering as a stabilised platform at a precise height above ground, measured by radar altimeter control, and with instrumental measurement of the absolute tilt, to about one minute, at the moment of taking the air photograph. He believes that this would revolutionise large-scale mapping, the accuracy of the latter being limited only by that of photographic depiction and photogrammetric measurement. Only a limited amount of ground control would be necessary.

Future technical progress of air survey is well assured by the remarkably successful work already undertaken by two notable British organisations, namely, the Air Survey Company, Ltd., and Hunting Aerosurveys, Ltd. The Air Survey Company, Ltd., was established twenty-five years ago, and has pioneered air survey both in this country and abroad; the organisation has undertaken many important contracts for the Ordnance Survey of Great Britain, and for the Governments of Egypt, India, Burma, the United Provinces, the Federated Malay States and Sarawak. Shortly after the end of the second World War the company resumed work with its own fleet of aircraft and highly skilled staff. The author recently examined its new "Dakota" aircraft, a standard passenger machine modified to accommodate air survey equipment towards the rear of the fuselage, and suitable for operation at 25,000ft.

The Hunting Group of air survey companies has branches in South Africa, Canada, Australia and New Zealand, with the European Headquarters in London. They are at present engaged on Ordnance Survey revision work for local authorities as well as on the production of large-scale plans to a scale of 1 in 1250 with contours at 5ft intervals required for town planning and civil engineering projects.

Turbo-Electric Oil Tanker "San Silvestre"

No. II—(*Continued from page 233, August 26th*)

Main Propelling Machinery

IN our first article we described the general hull design, the oil tanks and oil pumping machinery. We now pass to the main propelling machinery, and auxiliary equipment. The elevation and plan of the engine-room reproduced on the opposite page shows the general arrangement of the turbo-alternator, the propulsion motor, control desk, the Thompson La Mont boilers, the Cochran low-pressure boiler and the Thompson steam-to-steam boiler; also the auxiliary turbo-generator sets and the two motor generator sets. In the three accompanying engravings we illustrate the turbo-alternator set, the propulsion motor control panel and desk, and the main Thompson La Mont oil-fired boilers.

The complete turbo-electric propulsion and auxiliary equipment was designed, built and installed by the General Electric Company Ltd., to the specifications of Mr. W. L. Nelson, O.B.E., the superintendent engineer of the Eagle Oil and Shipping Company, the owners of the ship.

The single screw is driven by a 126 r.p.m., 9000 s.h.p. salient-pole marine propulsion motor, designed to give a speed of 15¼ knots on a six-hour trial. The normal power is 8300 s.h.p. at 120 r.p.m., corresponding to a service speed of 14¾ knots. The propulsion motor has its own closed circuit air cooler and emergency air cooling arrangements exactly similar to that of the alternator which we describe below.

The generator unit (see the accompanying illustration) is a single-casing G.E.C. Fraser and Chalmers high-pressure turbine, direct coupled to a G.E.C. three-phase, 3320-V alternator. The turbine takes steam at 475 lb per square inch, which is superheated to 775 deg. Fah. and exhausts to a 9000 square feet Worthington-Simpson surface condenser at a 28½in vacuum, with an average sea temperature of 73 deg. Fah. The alternator has a maximum continuous rating of 6930kW, or 9000 s.h.p. at a speed of 3230 r.p.m., and it is provided with a closed-circuit air cooler enclosed in the seating beneath the alternator.

The air cooler is designed to be suitable for tropical conditions and a 90 deg. Fah. sea water temperature. Both spray and leakage baffles to prevent any salt water being carried into the alternator are provided. In the unlikely event of the air cooler failing, the alternator can continue to run by drawing air from the engine-room, emergency doors and dampers for that purpose being fitted.

Control Arrangements

The alternator has six terminals at the bottom, three of which form the star point after passing through McColl protection transformers. The other three form mains which are connected by solid copper bus-bars enclosed in steel trunking and run to the high-tension switch cubicle, which is placed in a protected position under the stringer deck, immediately above which is the main drive control position. As will be seen from our engraving, the control desk is in two portions, with the servo-assisted reversing switch lever between them. The two other main controls are a starting wheel, and a speed-control wheel. All three are mechanical switch controls and are fully interlocked to ensure correct operational sequence and ensure that the reversing lever cannot be moved until excitation has been cut off from the alternator and main propulsion motor.

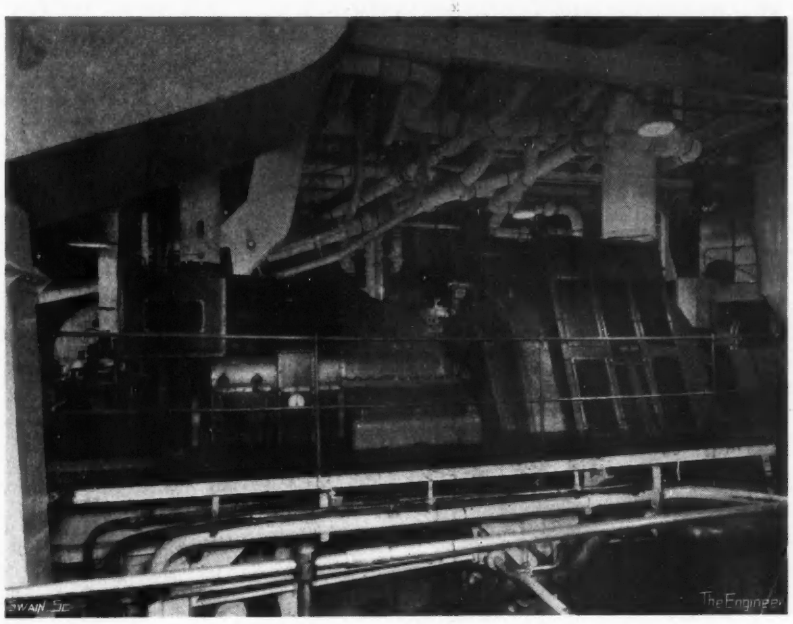
The sequence of starting commences by the first movement of the main starting wheel bringing in double excitation for the alternator and starting the main motor as an induction motor. Mechanical sequence stops prevent excitation being applied to the motor until it has accelerated to synchronising speed. In the meantime, the turbo-alternator is controlled by its speed governor at one-fifth full speed—until the final movement of the control wheel reduces the alternator excitation and unlocks the separate speed-control wheel to allow the governor speed to be raised as required.

All the essential instruments and gauges are situated in front of the engineer as he stands at the control desk, and thus arranged, permit very rapid manœuvring. A double-scale centre zero speed indicator shows both alternator and motor speeds and indicates synchronism, and the direction of rotation, for ahead or astern movement.

The right-hand wing of the control desk houses the McColl protection relays and integrating shaft horsepower meter, the control and instrument fuses, and a multi-point temperature indicator for readings from thermo-couples which are embedded in many points of both the alternator and the motor windings.

An electric engine-room telegraph of Siemens Brothers' make is mounted between the desks and, alongside, there is an alarm and running light panel giving indications from twenty-four different points—auxiliaries, levels, steering gear, &c. Of these, thirteen have Klaxon alarm indication, together with red and green lights. On the same panel there is a red/green lamp indicator giving warning of the humidity in the closed air circuits, of both alternator and main motor, should it approach the dew point—where moisture would precipitate in the windings. So as to prevent moisture precipitation heaters can be switched on. Both air circuits have high and low-temperature alarm thermometers.

An additional protective device consists of a Crockatt electric salinometer and alarm with eight points guarding the purity of main condensate, both turbo-generator condensates, both condensate discharger lines from the cargo oil pump condensers, the salt water and fresh water evaporator distillates, and the drains from the sea water heater of the cargo tank washing equipment.



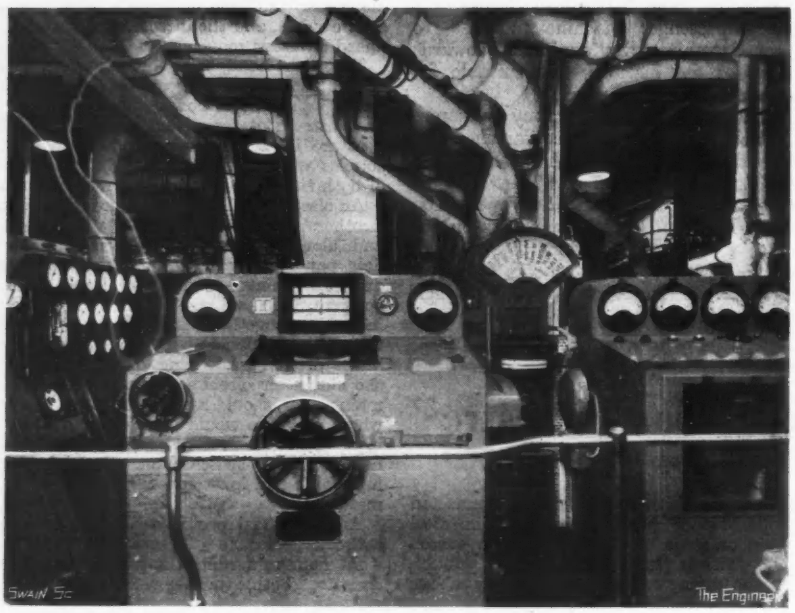
9000-S.H.P. TURBO-ALTERNATOR

Auxiliary Generating Plant

Electric power for operating the steering gear, all engine-room auxiliaries and the complete electric cooking apparatus in the galleys, is obtained from two G.E.C. 400-kW, 220-V d.c. turbo-generators, designed for operation in parallel. Each turbo-generator has an additional direct-coupled generator for the supply of excitation current to the main alternator, choice of source being made by switching from the main control point. Excitation of the main propulsion motor is provided by current taken from the low-tension switchboard through remote-controlled circuit breakers, the control

for which is on the main desk and can be used in emergency as a power cut-off.

The lubrication of the turbo-alternator is provided by two "Drysdale" Vertoil motor-driven pumps, which are furnished with a Monitor device and automatic starters, so that if the running pump stops the standby automatically starts. The pumps discharge through Auto-Klean duplex strainers to the turbine governor relays and through duplicate Serck oil coolers to gravity tanks for the bearings. There are also connections to the main motor bearings and to the main shaft Michell thrust block. 110-V current is provided by two 30-kW d.c. motor generator sets and a 100-kW, 200-V Mirrlees Bickerton and Day diesel generator is installed for emergency service.



CONTROL DESK

Main Boiler Plant

Main steam is raised in two oil-fired La Mont type forced circulation boilers designed and built by John Thompson Water Tube Boilers, Ltd., of Wolverhampton, which are designed for a working pressure of 500 lb per square inch, and a total superheated temperature of 800 deg. Fah. Hagan auto-combustion controls made by James Gordon and Co., Ltd., are fitted, together with Worthington-Simpson de-aerating and feed heating equipment, designed to give a final feed temperature of 310 deg. Fah. when dealing with a normal load capacity of 60,000 lb steam per hour. The burners are of the Wall-send pattern with Howden forced draught.

The La Mont boilers work on the forced circulation principle with Weir turbine-driven circulating pumps. All the boiler superheater and economiser tubes are so arranged that they are self-draining and self-venting, and give a small measure of natural circulation which enables steam to be quickly raised or the boilers banked without using the circulating pumps. It is claimed that the La Mont boilers only occupy about 50 per cent of the space required by natural circulation boilers of equal duty. Simplicity in control is effected by the injection of tertiary air into the gas stream before the superheater, so reducing the steam temperature when required. The boilers operate on forced draught only, and the entire boiler casings are surrounded with a pressurised air space between the casing and the outer jacket. The air heaters are made in two sections—a normal hot air heater and a small cold end air heater—so that corrosion is lessened and the small portion can be by-passed in an emergency. In operating under no-load conditions arrangements are made to circulate the economiser with hot boiler water. The instrumentation of the boilers is very complete and two main safety devices are included—a low water alarm and cut-off, and a device which shuts off the oil fuel should the forced circulation fail. There is a central chemical control station where the amount of injection needed is predetermined and routine tests and analyses are carried out.

Feed Arrangements

In specifying the feed system the owners laid special emphasis on supplying absolutely pure, gas-free water to the main boilers, and, to this end, all steam, feed and drains which could in any way be contaminated have been completely isolated from the main system. All tank heating steam and the exhaust from reciprocating machinery, &c., is therefore dealt with in a separate system. The 150 lb pressure steam is supplied from a Cochran boiler, 6000 lb per hour, and from a Thompson steam-steam generator, 10,000 lb per hour, which uses live steam from the main boilers as its heating medium. As already mentioned, the two large and two small cargo oil pumps in one of the two pump rooms, and the two large cargo oil pumps in the other, are all steam-turbine-driven, using reduced pressure desuperheated steam from the main boilers. Each pump room has its own surface condensing plant returning the condensate to the main system in the engine-room.

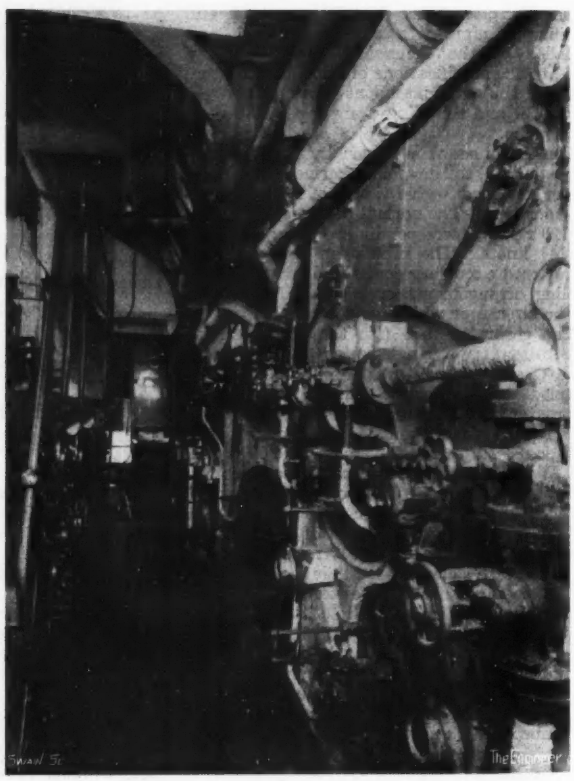
Careful investigation of the various conditions in which the ship would operate showed that, though a good distribution of exhaust heat could be obtained under normal sea-going conditions, there was a considerable amount of exhaust steam arising in other circumstances when the main feed system would have been unable to absorb this surplus and it would have to be spilled into the main condenser, a most undesirable expedient which has been known to result in turbine and condenser distortion, shown by leaking casing joints. It would also have made it necessary for vacuum to be kept on the main condenser while pumping cargo in port, and this in turn would require the turbine glands to be sealed and, consequently, the turbine to be kept rotating to avoid distortion of the turbine rotor due to the heat from the gland steam.

The surplus of low-pressure steam depends upon the amount of cargo tank heating in use affecting the amount of hot drains from the contaminated steam generator, and on the amount of cold condensate returned from the cargo oil pump condensers. The total, however, ranges between 200 lb per hour and 5400 lb per hour.

A new solution to this difficulty was found by adding mixed pressure governor gear to the G.E.C. 400-kW turbo-generators. These units can now accept all the surplus exhaust steam and convert it into useful work instead of losing its heat in the main condenser, and reduce correspondingly the high-pressure steam consumption of the turbo-generators. Another advantage is that the mixed-pressure governor gear keeps the exhaust steam pressure constant and as the steam supplied to the de-aerator is from the same line, the de-areator temperature is kept constant at optimum value under all conditions of feed flow.

There are two Weir's turbo-feed pumps, one being a standby, and the exhaust from them, together with the exhaust from the turbine-driven La Mont boiler circulating pumps, is taken into a feed heater under the control of a pressure regulating valve, maintaining constant feed temperature on this heater. The surplus exhaust steam which this heater cannot absorb spills over the de-aerator, and if its demand is satisfied the remainder goes to the l.p. inlet of the 400-kW turbo-generators.

There is a final stage of feed heating using bled steam from the main turbine final feed temperature of 310 deg. Fah.



BOILER ROOM

under to give a normal working conditions.

Special arrangements have also had to be made to cope with the very large amount of heat available in the drain from the contaminated steam boiler coils and a flash box was added to the base of the last feed heater to drop the drain temperature to that corresponding to the heater drain. The combined drains continue into another flash box on the base of the first heater, again dropping the temperature, and the total drains are pumped up to the de-aerator by a Worthington-Simpson vertical-spindle, motor-driven pump, so that they re-enter the feed and are de-aerated. This flash box made it possible to connect any steam pipe and other high-pressure drains, absorbing them without noise or nuisance in the engine-room.

The condenser and feed heating plant, designed and made by Worthington-Simpson, comprises a 9000-square-feet surface condenser with two full-duty motor-driven circulating pumps, two full-duty motor-driven extraction pumps, and two full-duty Weir's turbo-feed pumps. All the low-temperature and uncontaminated drains are brought back into a collecting tank and returned under float control into the main condenser so that they go through the de-aerating processes.

The make-up is provided by two 30-ton evaporators operated by steam from the low-pressure oil-fired Cochran vertical boiler or the steam-steam generator, each having its own sea-water-cooled distiller.

Arrangements have also been made for circulating feed water through the de-aerator and main boiler on first filling the boiler so as to reach complete de-aeration of the water in the boiler before steaming. Also there are connections for chemically dosing the feed and for bleeding back to the de-aerator from the boiler for correcting the pH value of the feed before it passes through feed pumps and feed heaters. The boilers can be blown down into the fresh water evaporator for salvaging the feed in case of over-correction of the concentration.

Other Auxiliary Machinery

In addition to the motor-driven pumps mentioned above, all of which have G.E.C. electrical equipment, G.E.C. motors and starters were provided for many other units, such as forced draught fans, boiler fuel pumps, refrigerator, air compressors and two 30-kW motor generators for supplying 110-V current for lighting.

The galley is electrically equipped by the G.E.C.

A big advance has been made in the design of the Butterworth tank-cleaning, pumping and heating installation in the engine-room. The heater is supplied with steam from the main La Mont boilers and to prevent contamination of the boiler feed water it was decided to keep the steam pressure above the pressure of the salt water so that any leakage would be from the feed system into the salt water system. This could quite easily have been arranged by utilising full boiler pressure, but it will readily be appreciated that there would have been trouble with this high-pressure high-temperature steam being used in a heat exchanger. Consequently, it was decided by the owners to bring the pressure of the steam down to 100 lb per square inch and desuperheat to saturation temperature. As the Butterworth system operates at 200 lb per square inch it was finally decided to instal a two-stage pump. This pump draws water from the sea in the first stage and discharges through a salt water heater. The second stage pump draws from the heater and discharges to deck through the Butterworth and fire line. In addition to the Butterworth pump discharging through this pipe-line standby connections are arranged from the sanitary pumps so that the same pipe-line can be used for normal deck washing services.

Sussex Industries Exhibition.—The fourth annual Sussex Industries Exhibition and Trade Fair is to be held at the Corn Exchange, Brighton, from September 14th to 24th. It will be open from 11 a.m. to 9 p.m. each day, Sunday excepted. The organising secretary is Miss M. Barnes, 3, Marlborough Place, Brighton, 1.

South African Engineering Notes

(From our South African Correspondent)

Power Stations

A series of new power stations is planned by the Electricity Supply Commission (Escom). First priority goes to the Witwatersrand area, as the Commission realises that an additional power station is urgently needed to meet the increasing demands of the new gold mines and factories. Other places earmarked for stations are Salt River (Cape Town), East London and Port Elizabeth. The Salt River venture is one of the biggest and will cost £6,000,000, primarily to provide extra power to Cape Town itself. Excavations have already started for the Worcester (Cape Province) power station, which will produce current for the proposed extended railway electrification from Bellville. The Vaal station (near Vereeniging) is being extended to make it a 300,000-kW station, but the Commission has also agreed to establish a further plant at Vierfontein in the Western Transvaal to cater for the Free State Goldfields. At present, power is being taken to the Odendaalsrust district by a land line from the Vaal station, but this source will obviously be inadequate within a year or two.

Rapid Growth of Welkom

The growth of Welkom, the new town 10 miles south-east of Odendaalsrust, shows how soon adequate rail, road, power and water facilities will be needed by the new Free State gold mines. Welkom will serve the mine of the same name, Western Holdings, Free State Geduld, the President Steyn, the President Brand and St. Helena properties. The construction of this town reveals the problems civil engineers are meeting in the Free State, as the lay-out is complicated by the fact that it is governed not only by the disposition of the mines mentioned above, but also by the fact that these properties require space for surface installations such as offices, native quarters, reduction works, shafts and winding houses and slimes and waste dams. Welkom will cover more than 10,000 acres and house initially a European population of about 20,000. For the next ten years the optimum number of inhabitants is placed at 40,000. Welkom is being planned in three zones, the centre one being for civic and commercial requirements, the inner ring for theatres, hotels, clubs, institutions and sports stadiums, and the third and outer zone being for residential purposes In the civic, or commercial zone, 60ft wide service roads will run down the backs of commercial plots to obviate the need for loading or unloading trade vehicles in the main streets, and also to ensure the maximum parking space in front of buildings. The main thoroughfares in the town will be either 220ft or 140ft wide and are planned to carry four and two carriageways respectively. The residential zone will be divided into neighbourhood units, and main traffic will be kept away from these units. As the countryside is comparatively flat, stormwater drainage is difficult and large drains will be provided. Natives working on the gold mines are being housed in separate townships, and under very different conditions to the "compounds" found at older mines on the Witwatersrand In the Free State, the natives will have single or married quarters, the single quarters comprising accommodation in which there will be ten occupants to a room, with a separate room for clothing and personal belongings. The dormitory block will be centrally-heated, and messing will be communal.

University Curricula

An effort to obtain an early revision of existing university engineering curricula in South Africa is to be made by the local Institute of Municipal Engineers. At the Institute's annual conference, held recently in Port Elizabeth, the Presidential Address was devoted largely to an appeal for a broader education for civil engineers, Mr. W. S. Lunn, the President, maintaining that to meet the demands now being made on him, the engineer's training had to prepare him for regional and town planning, equip him to assess the financial implications of his work, and give him a knowledge of law.

At a later stage of the conference, the Institute's secretary reported that municipal engineers were perturbed at the way in which their functions as town planners were being usurped.

"From the earliest stages of history, the responsibility for town planning and civic growth has been one of the primary functions of town engineers," declared the secretary. "Lately, attempts have been made to encourage the belief that the municipal engineer was not the right person to perform such functions. We are partly responsible for this state of affairs as, through lack of attention to planning tuition and training, the role of the municipal engineer in town planning has often been neglected."

The secretary added that the executive committe of the Institute has exhaustively examined the position and decided that weaknesses existed in the present university engineering curricula. It had therefore been agreed to join forces with the South African Institute of Civil Engineers in an effort to obtain an early revision of the curricula.

Cape Town Water Supply

At the end of the last war, Cape Town realised that the rising demand for water in the Mother City could not be served by the two pipe-lines then bringing supplies from the Steenbras reservoir, some 30 miles away. The City Council therefore decided to lay a further pipe-line at a cost of £1,500,000, the work to be done by the city engineer's department. The 6000 sections of pipe were all made by a Cape engineering company from steel plate imported from Britain. These pipes are electrically welded and treated inside and out with a bituminous material to prevent corrosion. Work began in September, 1947, and, with about 1000 more pipe lengths still to lay, is expected to finish before the end of this year. The considerable use of mechanised equipment has helped to overcome terrain difficulties, which included mountainous areas. A British excavator, for example, was brought out from the United Kingdom, complete with its special operator, who trained members of the Cape city engineer's department how to use it.

Pretoria "B" Power Station

Work has begun on the "B" municipal power station for Pretoria, which will be sited near the recently completed "A" station. When complete these two undertakings will together form one of the three biggest municipal stations in the Union. Ultimately, the "B" station will have six 30,000-kW turbo-alternators, nearly double the power capacity of the present "A" plant. Steam for the turbines will be generated by ten 210,000 lb per hour chain grate stoker boilers. As a start, two English Electric and four Yarrow boilers have been ordered and, it is hoped, they will be in operation by 1952. Two new cooling towers similar to that existing, which is the second largest in South Africa with a height of 260ft and a base diameter of 180ft, will be built. The new plant is planned to take care of Pretoria's growing need for electricity up to 1960. The main "bottle-necks" affecting the completion of the first section of the "B" plant by 1952 are the supply of high-pressure valves and piping.

Tinplate Mills

Next year, the South African Iron and Steel Corporation will start producing tinplate from its new mills now nearing completion at Vanderbijl Park. Machinery has already been imported from Britain and America for these mills, which are expected to save about £1,500,000 a year in dollar and sterling imports when they go into full production. At present no tinplate is made in South Africa, and the important export industry—food canning—is entirely dependent on overseas supplies. The new strip mill at Vanderbijl Park is not expected to meet all local demands, but it will satisfy most of them.

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THE OLYMPIA EXHIBITION

ON Thursday morning of last week, Sir John Anderson opened the Engineering and Marine Exhibition at Olympia, the latest of a series of such exhibitions held under a variety of titles biennially since 1906 apart from war periods. In doing so he remarked that "the engineering industry of this country is unique in that it maintains the tradition of the great pioneers who achieved fame in the past, and at the same time keeps absolutely up to date and is, indeed, in the forefront in applying for industrial purposes the latest scientific discoveries." That praise was by no means too high, as every visitor to this Exhibition will discover for himself. For though it is true that there are not to be found at the Exhibition many exhibits for which complete novelty can be claimed and if, indeed, many machines, engines, instruments and other devices seem at first glance very much the same as those seen at exhibitions before, it is found upon inquiry that much, often rather subtle, development has taken place in small changes of design or the substitution of newer materials for older ones. Sir John, at the lunch which followed the opening ceremony, referred particularly to one such factor. Great strides, he remarked, had been made in metallurgical processes in this country. By such applied research in metals we now had machines that had greater endurance, that saved weight, that processed metals faster in the machine shop and reduced wastage in cast components. Such developments are not immediately appreciated by the eye. But the inquiring mind will seek them out.

Obviously such a series of shows as these Exhibitions that have been held at Olympia as regularly as wars would permit are successful because "business" is done. That is a point that the organisers, have always very much appreciated. Following his father's example Mr. Kenneth Bridges continues to see to it that individuals, institutions and organisations of engineers and others are attracted to the Exhibition and that buyers and potential buyers from at home and abroad shall visit it. But there is more to an Exhibition than that it shall serve as a mart. That point, too, has been all along appreciated by the organisers. The holding of the Olympia show has been in the past, and still continues to be to-day, a social and technical occasion. An engineer is just as welcome on any of its stands because he is technically interested as he would be were he likely to place an order, and those whose job it is to attend upon the stands are not solely interested in sales, but take a pride in explaining to all and sundry the merits of the products displayed. In fact, in encouraging such an attitude, the organisers of the Exhibition have appreciated that for engineers the distribution of technical information through discussions at Institutions and through the medium of the technical press cannot be wholly complete. Above all things, an engineer likes to see a product "in the round," and that is the reason why, should he have occasion to visit a works he invariably hopes that he will be invited to go round the shops. At Olympia, it is true, products cannot be seen under manufacture. But engineers can admire the finished product; they can compare the ideas of one maker with those of another; they can learn what developments are taking place here and what changes are occurring there, and they can learn, too, not only about new devices, but also about older ones which, through some deficiency in their sources of information, they had not heard about before. Moreover, engineers who visit the Exhibition not only acquire information. They also provide it. For seeing the products of their industry "in the round" they cannot refrain from discussion. Many a firm has benefited and has been able to improve its products as a consequence of what it has learned at an Olympia Exhibition.

There is, then, no question in our minds that an exhibition like that at present in being at Olympia, which is organised not solely for the sake of obtaining orders, has great value. For until the Exhibition closes a considerable interchange of knowledge and experience will be taking place at Olympia. Nor, even if that interchange is often one-sided, as when curious youth receives instruction, is it without commercial value. For though the youthful engineer is seldom in a position to place orders for expensive machinery he is, after all, a potential buyer of the future. We have little patience with those who can think only in terms of present benefits. If an engineering firm is to succeed it must look to the future as well as the present. The elementary instruction of the young (even if it be not yet out of the knickerbocker stage) is, for a firm that looks forward to many decades of useful work, just as valuable as discussion with the aged whose experienced criticism it is equally unwise to neglect.

INDUSTRIAL DISPUTES

THE recent distressing recurrence of disputes which inflict injury on the country at a most difficult time is something which affects every citizen. It is not without its lamentable consequences on the engineering industry, and no apology is needed for referring here to the need for the exercise not only of wise moderation, but of convincing argument. We live in a world which is in a state of ferment, when large changes are in process, changes which, as we hope, may be so led as to produce results advantageous for mankind. But this benefit can only be possible where such changes are based upon a foundation of sanity and can be shown to accord with that funded experience of the past which may be said to act as a regulating principle in all human affairs. The excesses of fanatics will always trouble the world, and fanatics of all schools have, at their disposal to-day, unexampled publicity opportunities.

These publicity opportunities are also available to reasonable and honest men, whether they belong to what is called the capitalist class or whether they are leaders or members of trade unions. All, indeed, are members of a still larger group and as such form elements of the same body. Irrationality in one or the other damages both and there is no better way of preventing such suicidal exhibitions than by clear and practical exposition of the mutual obligations of one side to the other. It is certainly beyond all expression absurd that disputes should arise on grounds which, if calmly examined, would be found capable of immediate and peaceful solution. The British people, in all sections, have a sound sense of what is fair. They may be obstinate, but they are not, as a nation, fanatical. Among other things, they are very apt to respond to simple arguments put forward by those whom they regard as honest. There is great need in these days for a simplification of language. All sorts of pedantic and complicated expressions are scattered abroad where the plain English of John Bunyan would fly straight to the target. Words like "implementation" become what Caesar Augustus called "stinking savours." They are among the counters of those "sellers of smoke" who cause trouble wherever they

go. We want plain English and short words if we are to convince either dentists or dockers or anyone else. We also need an approach which, free from prejudice, carries conviction by its direct appeal to reason and imagination. Such an approach must be bottomed not on jargon, but on judgment.

It is related by the historian Livy that at a time when there was a revolution in Rome, one Menenius Agrippa, a respected senator, overwhelmed the arguments of certain noisy agitators by relating to the dissatisfied people the fable of the revolt against the belly. "In times of old," he said, "when every part of the body could think for itself and each had a separate will of its own, they all, with common consent, resolved to revolt against the belly. They knew no reason, they said, why they should toil from morning till night in its service, while the belly, in the meantime, lay at its ease in the midst of them all and indolently grew fat upon their labours. Accordingly, they one and all agreed to befriend it no more. The feet vowed they would no longer carry the load; the hands vowed they would not feed it; and the teeth averred they would not chew its food. Thus resolved, they all, for some time, showed their spirit, and kept their word; but soon found that, instead of mortifying the belly by these means, they only undid themselves; they languished for a while, and perceived, when too late, that it was owing to the belly that they had strength to work or courage to mutiny." We are told that this narration had an immediate effect upon the people, who unanimously cried out that Agrippa should lead them back to Rome. Surely this fable of the belly is not without its lesson for us to-day.

Obituary

BERNARD FRANCIS CLARK

We regret to have to record the death of Mr. Bernard Francis Clark, which occurred at his home, "Beaupre," Bowdon Road, Bowdon, Cheshire, on August 24th. For nearly thirty years he had been closely associated with Simon-Carves, Ltd., Cheadle Heath, of which he was a director and, until his retirement in 1945, head of the power plant department.

Bernard Francis Clark—or Frank Clark, as he was more generally known in the engineering industry—was born on January 4, 1876, and served his apprenticeship with the Blaenavon Iron and Steel Company. Altogether, he was with that company for eleven years, the last four of which were spent in the drawing-office. In 1899 he took up an appointment as senior draughtsman at the Brymbo Steel and Ingot Works, Wrexham, and during his stay of five years was concerned with a rebuilding scheme which included the installation of new open-hearth steel plant. Mr. Clark then went as chief draughtsman to the Shelton Iron and Steel Company, Ltd., Stoke-on-Trent, and subsequently as assistant engineer at the Middlesbrough works of the North-Eastern Steel Company, Ltd. In 1909 he was appointed assistant works manager of the iron and steel department of Palmer's Shipbuilding and Iron Company, Ltd., Jarrow-on-Tyne, and a year later became chief engineer of the Partington Iron and Steel Company, Ltd., Irlam. Mr. Clark continued with that firm until the end of the first world war, when he joined Stein and Atkinson, Ltd., as a director. In the two years or so which followed he was engaged principally on the design and construction of metallurgical furnaces and auxiliary machinery.

Mr. Clark's work for Simon-Carves, Ltd., began in September, 1920, when he became manager of the metallurgical, pulverised fuel and boiler departments. During his time in that appointment he successfully negotiated and directed several important contracts for power station boiler installations. Among them may be recalled the four pulverised fuel boilers, each with an evaporation of between 150,000 lb and 180,000 lb, which were supplied between 1926 and 1929 to the Princes Power Station, Nechells, Birmingham. At the time of their installation it was claimed that they were the largest power station boilers in this country. Mr. Clark was elected to the board of Simon-Carves, Ltd., in August, 1926. After his retirement from the power plant department four years ago he continued in the service of the company as a part-time director and consultant.

Mr. Clark was a member of the Institution of Civil Engineers, the Institution of Mechanical Engineers and the Iron and Steel Institute. His death, which followed an illness whilst on holiday, will be deeply mourned by numerous friends, not only in and around Manchester, but in electricity supply undertakings and many other branches of the engineering industry.

G. F. BURTT

Many of our readers in the profession of locomotive engineering will learn with regret of the death of Mr. George Frank Burtt, which occurred at Lewes, Sussex, on August 22nd. Mr. Burtt will be remembered especially by his long and active association with the Institution of Locomotive Engineers, of which he was a founder member, and of which for a number of years he was honorary secretary.

George Frank Burtt was born in 1871, and was educated at Colfe's Grammar School, Lewisham, and at the West Kent Grammar School. When he left school at the age of sixteen he entered the New Cross locomotive depot of the former London, Brighton and South Coast Railway, a step which marked the beginning of his professional career as a locomotive draughtsman. He remained at New Cross for thirteen years and was then transferred to the Brighton works, where he was engaged until his retirement in 1932, and to which he returned for a period during the second world war. It is of particular interest to recall, therefore, that during his years at New Cross and Brighton, Mr. Burtt served under six C.M.E.s, the first of whom was the late William Stroudley.

Mr. Burtt's work, however, was not confined to the field of locomotive draughtsmanship and photography. Mention has already been made of the part that he took in the development of the Institution of Locomotive Engineers, of which some years ago he was elected an Honorary Life Member. He was also the author of knowledgeable books dealing with the locomotives of the L.B. and S.C.R. and other lines now forming the Southern Region of British Railways, and of a book "Cross-Channel and Coastal Paddle Steamers," which was published in 1934.

Loans for Installation of Grass Driers.—The Ministry of Agriculture and the Department of Agriculture for Scotland state that to encourage the development of grass and forage crop drying a scheme of loans towards capital expenses of erection of grass-drying plant has been agreed.

Institution of Naval Architects

A special autumn meeting of the Institution of Naval Architects is being held this week in Copenhagen, by invitation of the Institution of Danish Civil Engineers and the Federation of Danish Shipbuilders. The party of members and their ladies who are attending the meeting from this country left London last Friday afternoon. The meeting began on Tuesday morning in the hall of the Institution of Danish Civil Engineers. In the absence abroad of the President of that Institution, an address of welcome was delivered by Direktor Orla Rode, M.Sc., Vice-President. It was followed by the presentation to His Majesty King Frederik IX of Denmark of the Diploma of Honorary Membership of the Institution of Naval Architects, which ceremony was performed by the President, Admiral of the Fleet Viscount Cunningham of Hyndhope. The meeting then proceeded to the discussion of papers.

Literature

SHORT NOTICES

Irrigation Research in India. By K. D. Green, A.M.I.C.E., Melbourne: J. J. Gourley, Government Printer.—This 78-page book gives a brief outline of the approach to problems of irrigation in India, in which country the area of land under irrigation is nearly as great as the combined irrigated areas of the rest of the world. It has been prepared by the senior designing engineer of the State Rivers and Water Supply Commission of Victoria. The author attended the annual meeting of the Indian Research Committee of the Central Board of Irrigation in 1947; he then spent ten weeks touring the irrigation works and research stations of India, in order to write this account of the problems and practice of irrigation research in India for the benefit of Australian engineers.

The book begins with a description of the physical and economic conditions peculiar to India, which influence the problems of irrigation, and continues with an outline of irrigation research work. Various administrative topics are dealt with, and a description is given of the techniques used in a number of Indian research stations, the lay-out of the stations being described, together with the hydraulic models constructed in them. The next section briefly describes a number of irrigation systems which the author visited, the descriptions mentioning, particularly, any problems solved with the aid of work with hydraulic models at the research stations. The book concludes with some notes on future schemes and some conclusions drawn by the author from his tour which have particular reference to the problems in Australia.

BOOKS RECEIVED

Atomic Energy Year Book. By John Tutin. London: Temple Press, Ltd., Bowling Green Lane, London, E.C.1. Price 21s.

Mercantile Year Book and Directory of Exports, 1949. London: Lindley-Jones and Brother, Ltd., 52, Bishopsgate, London, E.C.2.

Interpretive History of Flight. By M. J. B. Davy. London: H.M. Stationery Office, York House, Kingsway, W.C.2. Price 8s. 6d.

Paper Making. Kenley: The Technical Section of the Paper Makers' Association, St. Winifred's, Welcomes Road, Kenley, Surrey. Price 6s.

Specifications and Law on Engineering Works. By Walter C. Sadler. London: Chapman and Hall, Ltd., 37, Essex Street, London, W.C.2. Price 30s.

Radio Frequency Heating. By L. Hartshorn. London: George Allen and Unwin, Ltd., Ruskin House, 40, Museum Street, London, W.C.1. Price 21s.

Meter Engineering. Fifth Edition. By J. L. Ferns. London: Sir Isaac Pitman and Sons, Ltd., Pitman House, Parker Street, Kingsway, W.C.2. Price 18s.

Oxy-Acetylene Welding and Cutting. Fourth Edition. By Stuart Plumley. London: McGraw-Hill Publishing Company, Ltd., Aldwych House, London, W.C.2. Price 39s.

The British Association

No. I

AFTER an interval of thirty-three years, the British Association is again meeting in Newcastle-on-Tyne this year from August 30th to September 7th. Previous meetings were held in the North-East Coast town in 1838, 1863, 1889 and 1916, and there is every indication that there will be more than an average attendance on the present occasion. Some comment was made last year that the attendance at the Brighton meeting was unsatisfactory; but, taking the attendances over a long period of years, it is clear that there is a measure of geographical control over the figures. It is not without interest that one of the highest attendances in the history of the Association in this country was at the Newcastle meeting in 1863, when it reached 3335. There is a figure of 5044 in Australia in 1914, but then the meetings were held in five cities. There is no expectation in the Association that the figures of attendances at the annual meetings will show a progressively upward tendency, irrespective of venue or other circumstances.

The President of the Association this year is Sir John Russell, F.R.S., and his Address, as might be anticipated, from the position he held at Rothamsted for so many years, deals with food supplies.

Section G (Engineering)

In Section G (Engineering), the President is Sir Arthur Fleming, whose work in the electrical industry, especially in education, research and the application of science to industry, is so well known. A varied programme has been arranged with, as would be expected, some emphasis on coal-mining, although the general question of the present position of the coal industry in Great Britain is to be discussed jointly in Sections B (Chemistry), C (Geology) and F (Economics and Statistics).

The programme for Section G has rather been to select a general subject for discussion at most of the morning meetings and to have individual aspects of it dealt with by selected speakers, followed by a more or less general discussion. Thus, on Thursday, September 1st, the general subject is new materials and their engineering significance; on September 2nd it is ground subsidence; and on September 5th it is bridging the gap between science and industry, this latter being in connection with the Presidential Address, which this year is being given rather late in the meetings instead of on the first or second day. An innovation in Section G is that the last of the morning meetings is to be devoted to a series of papers by "young engineers," and they will deal with a variety of subjects.

Another change this year is that there are meetings of Section G in the afternoons as well as in the mornings, and the times of these meetings are fitted in with visits to works.

On the morning of September 1st three papers on "New Materials and Their Engineering Significance" were presented and there was a general discussion upon them.

New Dielectric and Semi-Conducting Materials

Dr. R. W. Sillars (Metropolitan-Vickers Electrical Company, Ltd.), presenting the paper on "New Dielectric and Semi-Conducting Materials," said that whilst the electrical engineer usually required his insulating materials to have as low a conductivity as possible under all circumstances and in all senses, and conductors to have the highest possible conductivity there was, nevertheless, a group of conducting materials which were of use to the engineer, particularly the light-current engineer, not by saving copper losses, but by enabling him to perform circuit conjuring tricks which were impracticable without them. Those materials, which fell into the class of electronic semi-conductors, displayed a fascinating variety of electrical properties. Electronic semi-conductors consisted of substances which were relatively poor conductors, but which, like metals, transported electricity by flow of electrons and not, like electrolytes, by flow of ions. A great many of them were compounds of metals, such as the oxides of copper, lead, nickel, titanium and innumerable compounds of many metals, but there were also the elements boron, silicon, germanium, selenium and tellurium. The major characteristics which these substances had in common were that their resistivity was acutely dependent on small changes of composition or of impurity content, that it fell with rising temperature and, furthermore, at electrical contacts with another material or another piece of the same material, a voltage was built up which was not proportional to the current and might depend on its direction.

Those, however, were generalisations, as not all semi-conductors displayed all those properties in all circumstances. They differed fundamentally from metallic conductors, in that the electrons which carried the current were a few which had temporarily escaped from rather weak attachments to fixed ions, where they would be held if the temperature was very low. Whereas the conducting electrons of a metal had no ties and could move freely at all temperatures, the conduction electrons in a semi-conductor were released by the thermal energy corresponding to the temperature, and after wandering about for a while returned to a fixed position until released again. The higher the temperature the more electrons were free at any instant, and the higher the conductivity. A semi-conductor was fundamentally an insulator which was too hot to insulate, even at room temperature.

The fixed ions from which these electrons were released were generally adventitious ones which did not properly belong to the lattice structure, and this type of material was called an "impurity semi-conductor," the so-called impurities being excesses of metal or oxygen. The excess, and therefore the conductivity, depended critically on the atmosphere and temperature of preparation, and many characteristics altered if the resistor was overheated. This might be one reason why such resistors were not as stable as would always be desired, though they were good enough for most purposes.

More recently, materials consisting of solid solutions of magnetic iron oxide (Fe_3O_4) in various salts—magnesium chromate, zinc chromate and zinc titanate—had been put forward, but these materials did not entirely fit into the picture of impurity semi-conductors. Their free electrons depended on the mixture of ferrous and ferric ions in the lattice, and their properties were less dependent on the exact conditions of production and less affected by heating in use. It was extremely probable that other materials would appear in due course.

The most direct use of these large temperature coefficients was for the measurement of temperature or radiation, especially where high sensitivity rather than precision of absolute value was required, and where delicate instruments and elaborate amplifying equipment was to be avoided. Another obvious use was for compensating the opposite change of resistance of copper in electrical instruments and voltage regulators, which could be done more efficiently by a small resistance of large temperature coefficient than by a swamp resistance of zero temperature coefficient.

The materials so far mentioned did not show any noticeable rectifying properties under the conditions discussed. Nevertheless, it was true that, in general, a contact between an impurity semi-conductor and some other conductor would rectify under suitable conditions, with the familiar type of volt-current curve, and if free surfaces of two pieces of similar semi-conductor were put in contact, a volt-current curve of a similar type but more or less symmetrical, i.e., non-rectifying, was often obtained.

The mechanism of conduction in the elements silicon and germanium was understood in considerable detail, thanks to a vast amount of painstaking theoretical and experimental work carried out largely in the U.S.A. during and after the war.

Referring to the fact that a contact between two free surfaces of the same semi-conducting material often had a non-linear volt-current curve, he pointed out that there were at least two materials where this fact was used. One was the silicon carbide resistor, which consisted of a large number of grains of this semi-conductor pressed together or held together in a bonding material. The sum of the characteristics of all the contacts between grains produced a resistance which fell as the current or voltage rose. The major application of this property at present was to the prevention of over-voltages either where a circuit was being interrupted or where a steep-front current surge might pass into equipment of high impedance, as when lightning induced surges in a transmission system. Another use of semi-conductors in connection with transmission lines was the production of high-resistance conducting films for grading potentials on porcelain insulators to prevent local concentration of electric stress. For that purpose the composition employed was a complex of iron oxide and various silicates, applied in the same manner as an ordinary glaze.

Turning to insulation for electrical machines, the author said there was no doubt that a major advance in machine design required the development of insulators which would withstand higher temperatures than the usual combinations of cellulose with Bakelite, glyptal, cellulose acetate and drying oil varnishes. Glass fabrics in combination with the more heat-stable organic varnishes were often used, but had disadvantages primarily due to the relative coarseness and brittleness of glass fibre. Recently, the technique had been developed of making asbestos paper, which, impregnated with a heat-resisting varnish, had found some uses where ability to withstand high temperature is more important than a high breakdown strength and low moisture absorption. The new fabric made from esters of terephthalic acid, known as "Terylene," promised to be useful, for it would withstand the comparatively high temperature of 180 deg. Cent., had a very low moisture absorption and could be woven into fine fabrics of good mechanical strength.

The author felt it could reasonably be hoped that the next decade or so would see in regular use plastic materials for both radio and power frequency applications

which would withstand considerably higher temperatures than those now common, and that new ceramic materials of properties unlike any that had been known in the past might become part of the regular armoury of radio engineers.

Magnetic Materials for Electrical Power Plant

Dr. F. Brailsford (Metropolitan-Vickers Electrical Company, Ltd.), in a paper on "Magnetic Materials for Electrical Power Plant," reviewed the progress and possibilities of improvement of magnetic materials with particular reference to those materials used in quantity in the electrical industry, viz., the iron and silicon-iron alloys. After indicating the characteristics and limitations of present materials, he said that power equipment had been brought to such a high state of development that further substantial progress depended upon the availability of better materials; the general improvement of magnetic materials, particularly the reduction of iron losses, were urgent needs. Designers of rotating machines and transformers were faced with the practical difficulty of dissipating waste heat without exceeding permissible temperature limits, and that problem was heavily aggravated by iron losses. For example, in a 50,000-kW turbo-alternator about 250kW of iron loss would be produced in the machine. In a large transformer core built from the best available British silicon steel there would be about 1kW of iron loss to every 2 or 2½ cubic feet of core. Those, with other losses, represented a high concentration of heat in a small space and adequate cooling entailed complications in design with a substantial increase in the size and cost of equipment. Moreover, the full iron loss occurred continuously in machines and transformers as long as they were excited, and independently of the load, and the wider question of this steady waste of power arose. The British Electricity Authority supplied a peak load of about 12,000MW. The very minimum transformer capacity to carry this load, bearing in mind that there were three or four transformations between generation and use, was estimated as 50,000MW, which alone would account for 200MW of iron loss. But, taking into account all the standby and other connected transformers and the losses in generators and motors, the average rate of iron loss could hardly be less than 500MW. The total installed capacity of Dunston B power station was about 200MW. Hence the point might be illustrated by saying that in the country as a whole the full continuous combined output of the installed generating capacity of Barton, Brimsdown B and Dunston B power stations must be bled off to feed those parasitic iron losses.

Another serious aspect from our standpoint was that America had left this country far behind in the production of high-quality electrical sheets, especially for transformers. From the point of view of overseas competition that situation should be quickly corrected.

The experimental work of Yensen, Cioffi and others had shown that if steel and sheet-making processes were controlled to keep impurities to a minimum and to produce a larger grain size, then considerable improvement in magnetic quality was possible. It was now American practice in producing some of the better grades of hot-rolled material to reduce carbon by a decarburising treatment on the sheet in its finished thickness, and to obtain a larger grain size by a special rolling technique. Material so treated showed an improvement over the ordinary hot-rolled product as used in this country for the last twenty years or more for turbo-generators, in that it was 40 per cent lower in loss and much superior in mechanical properties and in saturation value.

In cold-rolled silicon steels the most important advance since the investigations of Barrett, Brown and Hadfield, dating back some fifty years, had been the development of the directional cold-rolled transformer steels. This began in this country about 1930, but the successful extension and application of the process to the silicon steels was due to workers in the United States from about 1934 onwards. At the present time probably more than half of the total output of American transformer cores in all sizes was being made from cold-rolled silicon steel having an iron loss which was only about one-half of that of the best steel available in quantity in this country. Because of the directional properties, the material was unsuitable for rotating machines, but was entirely satisfactory for transformer cores even of the conventional built-up type.

Future developments were then discussed and, in conclusion, it was emphasised that Great Britain pioneered the subject discussed in the paper. But although the basic ideas were British, we had, largely because of the war and its economic after effects, fallen many years behind the Americans in the production of the highest-quality electrical sheet steels, especially for transformers. It was hoped that leeway would soon be made up, a result which could, however, only be achieved by a vigorous programme of applied research and development in this special subject on the steel and sheet-making side, backed up by fundamental research work on an adequate scale.

Metals for High Duty

Dr. R. W. Bailey, F.R.S. (Metropolitan-Vickers Electrical Company, Ltd.), in a paper on "Metals for High Duty," outlined the main developments and uses of high-duty metals which had characterised engineering progress and, in a considerable measure, made it possible.

The urgent development of gas turbines for aircraft during the last war forced the production of new and improved alloys for operating temperatures well in advance of those reached in steam plant. Fortunately, the desired life was very much shorter than that normally expected for the first line operation of steam power plant and working stresses could therefore be used which would have been quite inadmissible for steam plant. Indeed, for this reason, and aided by a measure of cooling, it had been possible to use ferritic steel turbine discs with entire success. But for blades, where the full gas temperature operated, materials of the highest capacity for duty at elevated temperatures had been essential. In this respect, this country's pioneer developments on jet propulsion, and the leading position attained therein, had been greatly aided by the early progress made here in producing heat-resisting alloys of superior strength, notably the Mond Nickel Company's "Nimonic" alloys, and the late Dr. W. H. Hatfield's "Rex 78" alloy. In the meantime, very extensive investigation and testing undertaken in the U.S.A. led to the production of alloys of comparable performance, accompanied by the appearance here of alloys of the same general type.

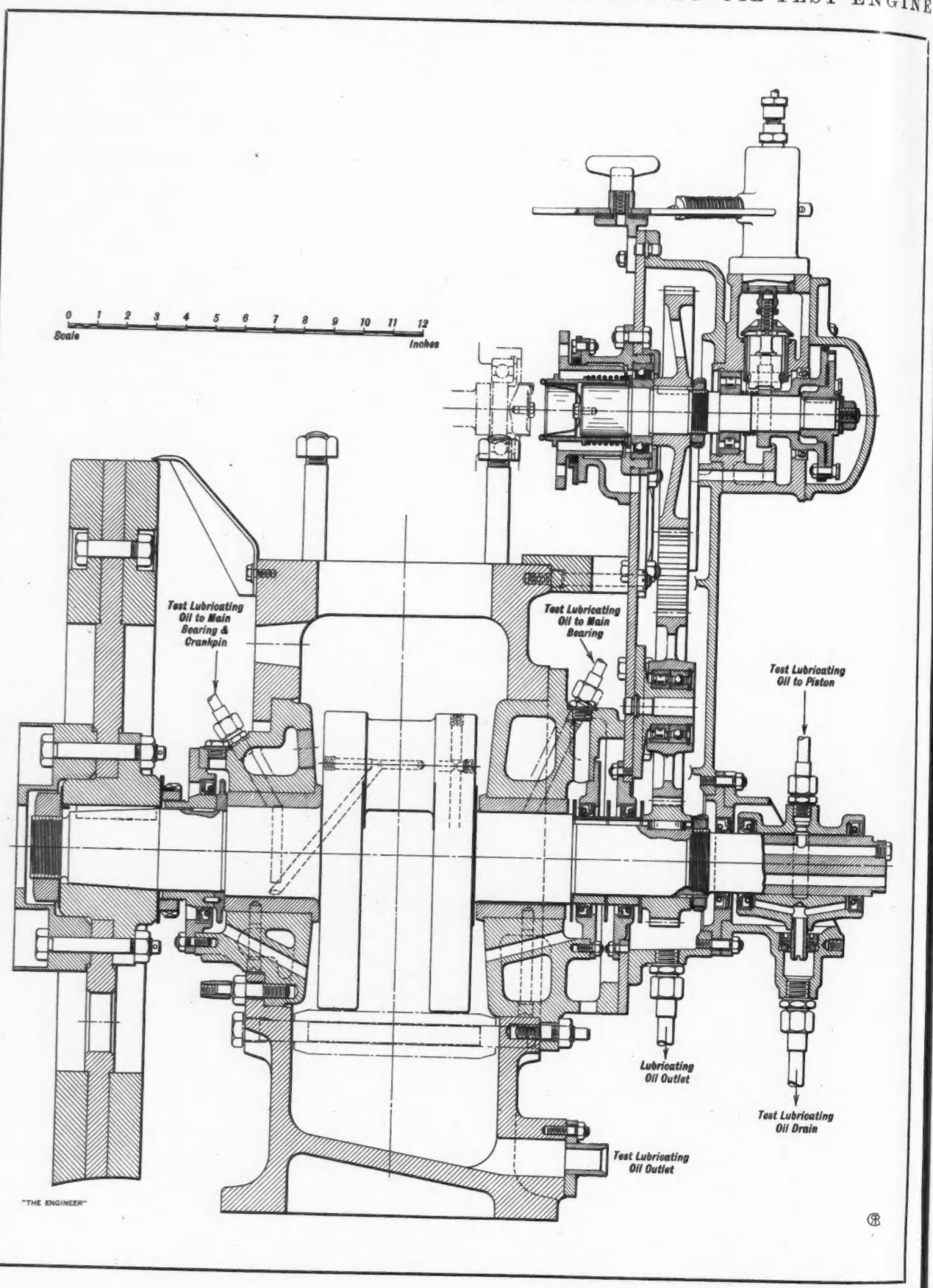
Referring to the fact that alloys resistant to deformation at high temperatures are naturally difficult to forge and usually not easy to machine, mention was made of the attention that had been given to precision casting by the "lost wax" or wax pattern method, and also to the fact that sintering had been considered or tried. Very creditable results had been obtained in making precision cast turbine blades and other parts, but so far their assured quality was inferior to that obtained with wrought material. Moving blades obviously demanded a quality standard higher than that permissible for stationary blades, and alloys which had proved fully satisfactory for this purpose were the vitallium group, which was extensively used for the exhaust turbine supercharger blades in U.S.A., "Super Fortress" engines in the recent war, and "H.R. Crown Max." (Firth Vickers). Experience with complex alloys had shown that an increase in size might multiply manufacturing difficulties unexpectedly and seriously; therefore in the development of new alloys of promising performance an early exploration and assessment of the influence of size should be made.

The process of sintering, already extensively used in the production of high-duty carbide metal cutting tools, and of carbide armour-piercing projectiles, had possibilities in the case of small parts where casting and hot working processes were impossible or impracticable. As applied hitherto, the process was relatively expensive and had been confined principally to cases where the cost was fully justified by the economic results. The process, however, was now being given wider uses as a means of producing parts in common metals and alloys which were competitive with die castings and stampings, provided the quantities were very large. The solidity or density of the metal produced was dependent on the pressure applied to the "compact" before sintering, and was a function also of the time of sintering and its temperature, which would naturally be as high as practicable. Usually, there would be pores distributed through the final material. Nevertheless, a strength fully sufficient for the application concerned would be provided, for which the sintering conditions would be chosen. An interesting application of sintering, where the pores had virtue in providing a metal to meet high-duty conditions in the form of high temperatures, was where the metal was porous and cooling media, gaseous or liquid, could flow through the metal pores. In the case of liquid cooling media, evaporation would take place at the heated surface to which the liquid flowed, and the method had appropriately been termed "sweat cooling."

(*To be continued*)

Beilby Memorial Awards.—From the interest derived from the invested capital of the Sir George Beilby Memorial Fund, at intervals to be determined by the administrators, representing the Royal Institute of Chemistry, the Society of Chemical Industry and the Institute of Metals, awards are made to British investigators in science to mark appreciation of records of distinguished work. Preference is given to investigations relating to the special interests of Sir George Beilby, including problems connected with fuel economy, chemical engineering and metallurgy, and awards are made, not on the result of any competition, but in recognition of continuous work of exceptional merit, bearing evidence of distinct advancement in science and practice. In general, awards are not applicable to workers of established repute, but are granted as an encouragement to younger men who have done original independent work of exceptional merit over a period of years. In recent years the amount of each award has commonly been 100 guineas. It is announced that consideration will be given to the making of an award or awards from the fund early in 1950, and the administrators will therefore be glad to have their attention drawn to outstanding work of the nature indicated, not later than December 31, 1949. All communications should be addressed to the Convener, Administrators of the Sir George Beilby Memorial Fund, Royal Institute of Chemistry, 30, Russell Square, London, W.C.1.

CRANKCASE UNIT OF SHELL-RICARDO LUBRICATING OIL TEST ENGINE


0 1 2 3 4 5 6 7 8 9 10 11 12
Scale
Inches
Test Lubricating Oil to Main Bearing & Crankpin
Test Lubricating Oil to Main Bearing
Test Lubricating Oil to Piston
Lubricating Oil Outlet
Test Lubricating Oil Drain
Test Lubricating Oil Outlet
"THE ENGINEER"

The Shell-Ricardo Lubricating Oil Test Engine

It is not easy to assess the ability of an oil to resist oxidation and deterioration arising from products of combustion by any laboratory test. In fact, no laboratory oxidation test has yet been devised to our knowledge, which will satisfactorily predict the behaviour of an oil in service. Ideally this would be done by testing the oils in engines under actual service conditions. Such tests would, however, be both lengthy and costly and the difficulty of reproducing the operating conditions would make accurate comparative work almost impossible. For this reason accelerated engine tests, that is, tests on engines in which the conditions of load and temperature have been so increased in severity as to produce the effect of, say, 1000 hours' running in 50 to 100 hours, are the more usual solutions adopted for routine rating within the industry.

The only recognised standard engine tests for diesel lubricating oils in general use at present are those required for the U.S. Army Specification 2104B and the U.S. Navy 9000 series for high duty lubrication. They are, of course, of American origin and require Caterpillar, Chevrolet or G.M. diesel test engines of American manufacture. These engines are not always easy to obtain in this country and are not necessarily representative of British practice. In addition the tests themselves, with one possible exception, are not entirely suitable for rating modern heavy duty oils. The need has therefore been felt for some time for a British lubricating oil test engine of such a type that would enable a wide range of tests to be carried out on the one unit. These tests, while being generally similar in nature to the American L series, would in all probability involve more severe conditions of load and temperature to cover future developments in lubricants and service requirements.

It was to meet this need that the Shell Group and Ricardo and Co., Eng. (1927), Ltd., co-operated in the design and manufacture of a suitable engine under the aegis of the Engine Tests of Lubricants Panel of the Institute of Petroleum. Two engines of this type have already been manufactured and one has successfully completed a 100-hour type test at the Thornton Research Centre. It seems opportune, therefore, to present some general description of this unit.

Design Specification

The more important characteristics for a lubricating oil test engine are the greatest possible flexibility of operating conditions, consistency of performance, and ease of access to all important parts for cleaning and inspection. These considerations formed the basis of the design specification of the engine. The principle requirements were that :—

(1) The engine should embody a crankcase/crankshaft assembly on to which could be bolted various types of cylinder. Thus the possible range of tests would be large and the number of different oil-testing engines now in use could be reduced.

(2) The crankcase/crankshaft assembly should be of sturdy construction to enable it to operate satisfactorily for long hours at high outputs and should be such that with a wet sump efficient lubrication could be obtained with not more than two gallons of oil.

(3) Dismantling and assembly of the unit should be easily accomplished. It should be possible to exchange the various cylinder assemblies rapidly and to remove the piston from the connecting rod without disturbing the big-end bearing.

(4) The piston temperature control should be accurate, as the ring belt temperature will largely influence the ring-sticking and carbon-forming tendencies of the oil.

(5) The oil circulation system should consist of two distinct circuits, one supplying the valve cams and timing gears with a straight mineral oil, and the other supplying the test oil to the rest of the engine, the supply cooling the piston being capable of separate control. Separation of the oil circuits in this way would, of course, facilitate the cleaning of the engine between tests as it would obviate the necessity of disturbing the parts of the engine lubricated by the straight mineral oil.

(6) The internal surface of the crankcase and various oilways should be smooth and free from pockets.

(7) Combined copper in bearing metals would be allowed but otherwise copper and copper alloy should not be used owing to their catalytic effect on lubricating oil deterioration. For this reason all the oil-pipe work and the gear pumps should be of ferrous metal.

(8) Knowledge of the temperatures at various points in the engine is very important and reasonable provision should be made for thermocouples in the piston, cylinder liner, crankpin and main bearings.

The engine was designed with the following maximum performance requirements in view. It is, of course, unlikely that all extremes of performance will be required simultaneously. The normal speed was to be about 1200 r.p.m. and the maximum 2000 r.p.m. ; the maximum load 300 lb per square inch b.m.e.p. at 1200 r.p.m. ; the duration 500 hours, and the coolant temperatures of the same order of magnitude as those specified for the L series of tests.

Description of Engine

The unit is designed with a stroke of 6in, a size which enables a large selection of typical modern high-speed diesel engine cylinders to be fitted to the one crankcase. So far two combustion systems, direct injection and compression swirl, both of 4¼in bore, have been run in the engine and a two-stroke system has been designed but not yet tested.

Our drawing shows the universal crankcase section, the internal surface of which is shot-blasted to a smooth finish to enable it to be cleaned easily. The crankshaft is made of Meehanite cast iron and is supported by two main bearings consisting of steel shells lined with white metal. The bearing housings are so designed as to allow the crankshaft to be removed without disturbing the bearings. Two removable rollers have been provided to support the crankshaft when this operation is being carried out. The flywheel has been made so that the outer rim and web can be removed from the inner boss, thus allowing the whole crankshaft assembly to pass through the crankcase.

The big-end bearing consists of two half-shells, the top half being lined with 70/30 copper/lead and the bottom half with white metal. The connecting rod is of H-section 0·45 per cent carbon steel and is interchangeable between the various types of cylinder. The small-end bearing consists of a fully-floating plain Y-alloy bearing running in a hardened steel bush.

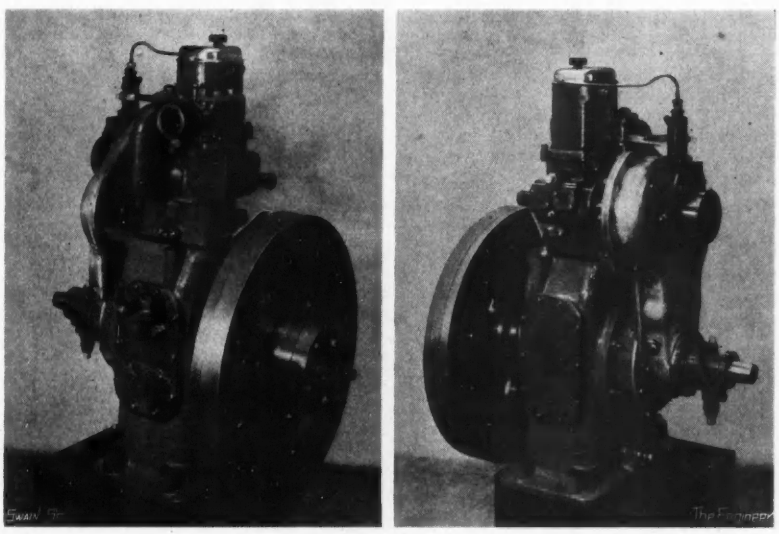
The drive to the camshaft is through a train of gears driven from the front end of the crankshaft. From the spindle of the top timing gear the drive is taken through an internally splined sleeve to the camshaft. This sleeve can be disengaged and held with a spring clip so that it does not impede the removal of the cylinder. Some variation in the valve timing can be obtained by suitable adjustment of this sleeve and the timing gear, the minimum change which it is possible to make being 3·8 crank degrees.

The other end of the timing gear spindle drives the fuel pump cam. The fuel pump itself is of the flange type (C.A.V. Type No. BPFIB70B03) without advance and retard mechanism. The pump timing can be adjusted statically by rotating the outer sleeve, which forms part of the pump camshaft relative to the inner shaft, these two members being secured by locking the two end plates together. These plates are drilled with two series of holes, which give a vernier adjustment. The minimum variation obtainable by adjustment of the relative positions of these two plates is 2·6 crank degrees. A fine adjustment can also be obtained by alteration of the pump tappet.

The lubricating oil system is divided into two main circuits, one supplying the camshaft, the fuel pump cam and the timing gears with a straight mineral oil, and the other supplying the test oil to the main bearings, big-end and rockers.

The mineral oil is fed directly to each place and is allowed to flow by gravity down the inside of the timing case to an outlet at the bottom. Each pair of timing gears has its own individual supply.

The test oil is supplied to each individual main bearing from a common source, the flywheel end inlet also feeding the big-end bearing. The oil flowing from the rockers to the sump by-passes the cambox through an external pipe to avoid contaminating the gear oil. In order that oil from one circuit should not



OIL TEST ENGINE WITH D.I. CYLINDER AND HEAD

pass into the other circuit each system is isolated by a number of "Super" oil seals fitted along the crankshaft.

To avoid passing the piston cooling oil through the main bearing and to enable an accurate control to be obtained, a separate feed has been arranged to supply oil to the piston. The oil is fed into a fully-floating "banjo" fitting on the timing end of the crankshaft from which it passes through the crankshaft and crankpin up the connecting rod to the piston. This oil, as well as that supplied to the main bearings, big-end and rockers, is scavenged from the base of the crankcase.

The photographs reproduced on page 259 show the engine assembled with a proprietary direct-injection combustion system.

Performance

The performance of the engine depends, of course, on the particular combustion system with which it is fitted. Thus, of the two cylinders so far tested, the direct-injection and the Comet Mk. III, both have given the expected power output and fuel consumption on an indicated basis. The brake performance figures on the Shell-Ricardo crankcase are necessarily somewhat low because of the relatively high friction losses of the unit. These high friction losses are an inevitable accompaniment of the larger bearing areas necessary to ensure complete mechanical reliability under all conditions of load and speed. The oil seals on the crankshaft provide an additional source of loss. From the point of view of the rating of the oil, however, it is the indicated performance of the engine which is important.

The crankcase fitted with the direct-injection combustion system has now completed a 100-hour type test at 1600 r.p.m. and 83 lb per square inch b.m.e.p., equivalent to 115 lb per square inch i.m.e.p. or to 90 lb per square inch b.m.e.p. on the usual industrial single-cylinder crankcase. All moving parts were found to be in perfect condition at the conclusion of this test.

It is satisfactory to note that the "Super" oil seals gave good service at oil inlet temperatures up to 100 deg. Cent. Tests have not yet been carried out at higher temperatures but, if this design should prove unsuitable under these conditions, mechanical seals of the piston-ring type are available.

All the running spares of the direct-injection version are of proprietary manufacture and are readily available in large numbers, a fact of considerable importance in routine engine test work.

The mechanical reliability of the design having been proved, the next task is to evolve a suitable engine test technique for rating lubricating oils, which will accurately predict their performance in service. This programme, organised and supervised by the Engine Tests of Lubricants Panel of the Institute of Petroleum, will demand the fullest co-operation from both the oil companies and the diesel engine manufacturers and users.

It may be as well to mention that although the engine has been designed as a lubricating oil test unit, such a sturdy universal crankcase will probably find many other applications as a general research tool. Thus, technical colleges, universities and research institutions would probably find the engine particularly well suited to investigations on fuels and combustion systems. Diesel engine manufacturers may also find it useful to have an established basic unit on which to carry out development work on new combustion chamber and top assembly designs. The unit may also be adapted for gasoline operation as a carburettor engine.

Bristol "Proteus" Propeller-Turbine Aero-Engine

DETAILS of the Bristol "Proteus" propeller-turbine aero-engine are now available for publication.

The "Proteus," which first ran in January, 1947, is the second of the Bristol production turbines. Though less in diameter (38·5in) than that of its predecessor, the "Theseus," it is considerably more powerful. It has been designed for economical operation at 300 to 400 m.p.h., at altitudes of 30,000ft to 40,000ft, and is particularly suitable for "buried" installation within the wing of an aircraft. The turbine develops a maximum power of 3200 propeller s.h.p. at sea-level static conditions, plus 800 lb jet thrust. At 350 m.p.h. at 35,000ft it develops 1260 s.h.p., plus 560 lb jet thrust. Specific fuel consumption at sea level is 0·688 lb/s.h.p./hour, dropping to 0·510 lb/s.h.p./hour at 35,000ft (350 m.p.h.).

The "Proteus" will be installed in Britain's two largest aircraft—the 130-ton "Brabazon" Mk. 2, and the 140-ton Saunders-Roe "Princess" flying-boat. Later production models of the Bristol "Type 175" aircraft, twenty-five of which are on order by B.O.A.C., for operation over the medium range Empire routes, will also have "Proteus" engines, to give, it is estimated, a cruising speed at least 75 m.p.h. faster than that of the "Constellation." For the "Brabazon" Mk. 2 and the "Princess," a twin-coupled "Proteus" power unit has been developed. The "Brabazon" will use eight "Proteus" units arranged in two coupled pairs in each wing. The "Princess" will have ten "Proteus" units, eight arranged as on the "Brabazon," with, in addition, a single turbine in the outboard position on each wing.

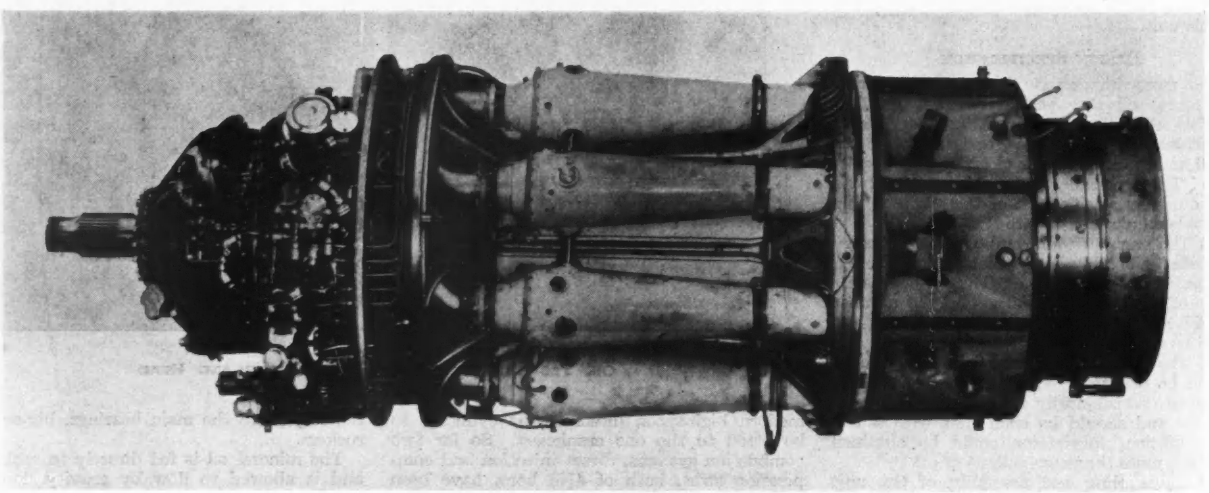
The Bristol "Proteus" has been designed as a high compression gas turbine engine, to obtain low fuel consumption and to provide a high power output for a comparatively small overall size. These characteristics make it suitable for installation in aircraft where fuel economy is an important consideration, while its compactness enables it to be fitted in aircraft wings with little interference to their aerodynamic properties.

Description of Engine

A noteworthy feature of the "Proteus," which it shares with other Bristol propeller turbines, is the mechanical separation of the propeller and compressor turbines, sometimes referred to as a "free turbine" arrangement. This arrangement, as compared with the single-shaft turbine arrangement, simplifies the propeller system and makes engine-starting easier so that a smaller starter motor can be used.

Air enters the unit at the rear of the compressor, through ducts to a plenum chamber, and passes through a twelve-stage axial compressor before entering a single centrifugal stage. From the centrifugal compressor the compressed air flows into eight combustion chambers, which fit closely round the compressor casing and help to give the unit its compact lay-out. A reversal of the direction of the airflow from forward through the compressor to rearward through the combustion chambers reduces the length of the unit considerably. The hot gases then pass through suitably shaped ducts to a first row of turbine nozzles. Three turbine stages are used, the first two rotors coupled together, providing the power required to drive the compressor, whilst a third stage turbine is coupled to a shaft which passes through the centre of the compressor and drives the propeller through an epicyclic reduction gear. Finally, after leaving the turbine, the gases pass to a controllable orifice nozzle, where the remaining energy provides a jet thrust, to augment the thrust delivered from the propeller.

The compact arrangement, bearing in mind the small overall diameter already quoted, is noticeable in our illustration below of the complete power plant. The overall length without exhaust cone and jet pipe is 113·35in and the bare weight 2900 lb.



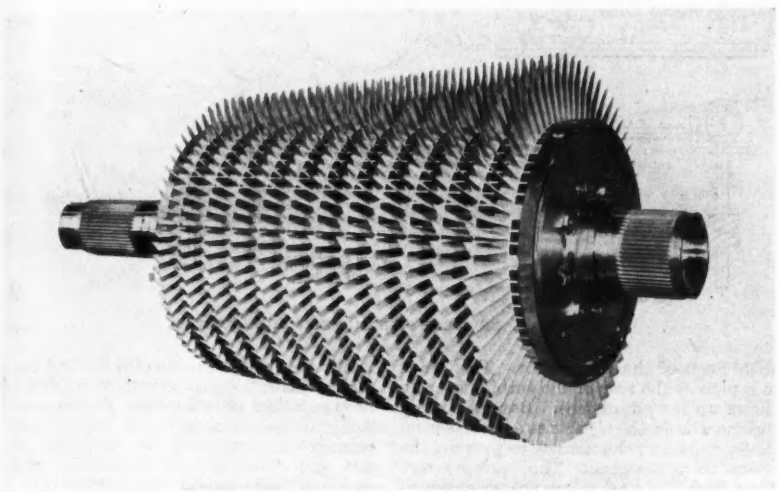
3200-S.H.P. "PROTEUS" PROPELLER-TURBINE UNIT

Compressor

The compressor is a twelve-stage axial unit, followed by a single centrifugal stage, designed to rotate at a maximum speed of 10,000

r.p.m. Because of the high rotational speed the compressor rotor is of disc construction, as illustrated herewith. Each of the twelve discs supports a single rotor stage. At each end they are bolted to hollow steel shafts, the whole assembly being held together by eight long high-tensile bolts, passing through the twelve stages. These bolts do not undergo any shear stress, as the torque is transmitted from one disc to the next by means of dowels let into the face of each disc.

The compressor blades are of low camber and have a high-speed aerofoil section. The discs and blades are made from light alloy, the blades being anodised. The rotor blades have "fir-tree" roots and fit into axial grooves in the rotor, spaced by distance pieces. The stator



TWELVE-STAGE AXIAL COMPRESSOR ROTOR

blades fit into circumferential grooves of dovetail section in the compressor casing and are held in position by metal strips, which are bolted on to the casing. Holes between the roots of the stator blades enable air to be bled off at certain stages for cooling purposes. The compressor casing is cast in two halves, which are bolted together. The blades are held rigidly by tightening bolts connected to four rows of wedges inserted in the grooves into which the blade roots are fitted.

The air, on leaving the axial compressor, passes through an annular duct in the intermediate casing before it enters the centrifugal stage. Eight guide vanes in this duct support the centre section, in which are housed two ball bearings, which support the front end of the compressor shaft.

Because of the temperature rise in the axial compressor under maximum r.p.m. conditions, and the high rotational speed, the double shrouded centrifugal impeller is made of steel. It is bolted to a short shaft running in a roller bearing, and is sealed on each side by labyrinth seals to prevent air passing to the intermediate casing or the gear casing.

Combustion Chambers

From the diffuser casing the compressed air flows to eight combustion chambers fitted round the compressor casing. They are of conventional design, with a centrally placed burner at the upstream end of the chamber. The air is led in through a small swirl casing, followed by primary and secondary air holes in the liner walls. Swirl is imparted both to the fuel prior to atomisation and to the incoming air to ensure good mixing and a centrally burning flame. This follows standard practice and has been proved to be successful. The combustion chambers are interconnected to allow the flame to pass from one to the next, and only two have igniter plugs fitted; the passages also ensure that all the chambers are at the same pressure. Plugs in the outer casing hold the liners in position, while the downstream end of the liner has a spacing ring attached, which is free to slide in the outer casing, thus allowing for expansion. The liner is made from "Nimonic 75" and the outer casing from mild steel sheet sprayed with aluminium; the air space between them is continued on in the connecting pipe leading to the breechespiece fitting on to the turbine casing.

The combustion chambers are rather longer than in previous designs, ensuring that the hot gases are thoroughly mixed and at an even temperature before entering the turbine.

Turbine

The turbine wheels are of heat-resisting stainless steel carrying turbine blades of "Nimonic 80," held in slots of "fir-tree" cross-section. The turbine nozzles are also of "Nimonic 80" and are cast in segments containing three to seven blades, varying with the stage. The segments are bolted on to diaphragms between the turbine wheels, which support labyrinth seals. Because of the high pressure drop through the turbine, the annular area between the entrance and exit of the second and third stage nozzles increases considerably. This consideration calls for fairly long sections for the stator blades so that the expansion is not too rapid.

The first turbine wheel has an integral short shaft, on which is carried a toothed coupling to drive the compressor. This rotor and the second-stage rotor have radial serrations on adjoining faces, and are clamped together by a sleeve passing through their bores. The short extension shaft runs in two bearings located by the turbine mounting spider. The rearmost of these is a ball bearing, which takes the thrust from the turbine. The driving shaft couples on to the compressor shaft by means of engaging gear teeth, so that the compressor and turbine sections of the engine can be assembled separately and coupled together afterwards. It also allows the two components to expand axially, independently of one another.

As the exhaust gases become cooler through the stages, greater stresses can be withstood in the turbine components and advantage is taken of this in the third stage to run the propeller turbine wheel at slightly higher speed. At maximum speed this is 10,700 r.p.m., compared with the 10,000 r.p.m. of the compressor. The thrust from this disc is taken on a ball bearing located in the rear casing, while the forward end of the shaft couples to the propeller shaft in a similar way to the compressor assembly. The third-stage turbine rotor is illustrated herewith.

Reduction Gear

A high ratio of reduction in speed is necessary between the propeller turbine and the propeller, for the propeller to operate efficiently. This ratio is 11·1 : 1, or 11·9 : 1, and is through a compound epicyclic train, as illustrated herewith. Power is supplied to a sun wheel, which drives four planet wheels. The reaction between the small planet gears against the fixed gear causes their axes to rotate, thus driving the propeller shaft. The load on the fixed gear is balanced by a torquemeter comprising eight cylinders and pistons, containing oil under pressure. From this pressure the power supplied to the propeller can be measured to provide a reliable indication of the turbine performance. The planet gears are enclosed in a casing, which rotates with them. The casing bolts on to the propeller shaft and holds the four shafts for the planet wheels in position. The gearing is supported at its front and by means of a ball bearing on the propeller shaft, and at the rear by a roller bearing.

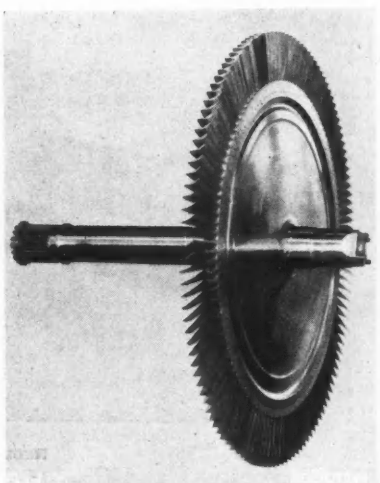
Starter and Accessory Drives

Two starter motors are mounted at the top of the gear casing and are inclined at 100 deg. to one another, as shown in the diagram overleaf. These motors drive a bevel gear *A*, which is connected to the spur gear *B* through a dog clutch. The gear wheel *B* engages with a gear wheel *C*, which is splined on to the compressor rotor shaft.

The gear *C* also forms the connecting link between the compressor shaft and the drive to the fuel and oil pumps. A spur gear *D*, meshing with the gear *C*, drives the oil pumps through a set of bevel gears below the propeller shaft. The oil pumps and sump are at the bottom of the gear casing. The fuel pump, just above the centre line on the side of the gear casing, is also driven from the gear *D* through a gear *E* and another set of bevel gears *F*. Provision is made for another fuel pump or other accessory drive on the opposite side of the casing.

Oil System

Oil is fed from a tank to a main oil pump below the forward gear casing. This pump delivers oil at a pressure of 650 lb per square inch to the propeller pitch control mechanism and to a reducing valve. The propeller pitch control is operated by a floating piston sliding in a fixed cylinder, the position of the piston being controlled by oil from the differential pump, with a manual over-ride for feathering or braking. Motion of the piston in one direction uncovers ports in the cylinder, which



PROPELLER DRIVE THIRD-STAGE TURBINE ROTOR

causes a coarsening of the propeller pitch, and vice versa.

The reducing valve delivers oil at a pressure of 80 lb per square inch to three outlets. One outlet supplies oil to a differential pump and also to the reduction gear, where it acts simply as a lubricant. The second outlet feeds the dynamometer pump, while the third outlet delivers oil to a second valve, where its pressure is reduced to 30 lb per square inch, to feed a metering pump. The metering pump, as its name implies, delivers a predetermined flow of oil directly to six sets of bearings and

indirectly to two other bearings for cooling and lubrication. The oil is drained from these bearings and the bottom of the reduction gear casing to the sump, from which it is returned to the tank through a filter, scavenge pump and oil cooler.

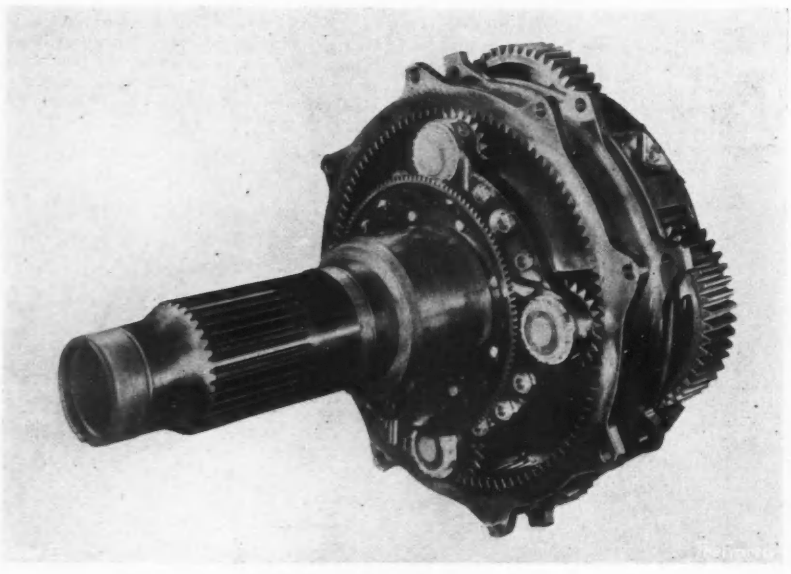
Differential Pump.—The differential pump serves to maintain a constant ratio between the compressor speed and the propeller turbine speed. In this pump both the pump casing and the driving wheel of the gearing rotate. The speed of rotation of the pump casing is governed by a drive from the compressor while the gear wheel is driven from the propeller turbine shaft. If the compressor and turbine are running at speeds in the correct ratio, there will be no relative movement between the pump and the driving gear. Should, however, the ratio deviate from the correct value, then the driving gear will rotate relatively to the casing and cause an idling gear to rotate in turn. If the turbine speed is too high, oil is pumped from the differential pump to one side of the control valve, which increases the propeller pitch, and so restores the turbine speed. If the turbine speed is too low, the differential pump works in the reverse direction and the propeller pitch becomes finer.

Cooling System

To prevent the turbine wheels from overheating, they are cooled by a flow of air passing over their surfaces. The air is obtained from the compressor at various stages. For the first stage turbine, where the exhaust gases are at high pressure, air is taken from the volute casing after having passed through the axial compressor. It is led through a pipe to two of the spider arms of the supporting casing. Passing down the hollow arm, it separates into either the diaphragm annulus supporting the first stage rotors or through a passage into an air ring between two labyrinth seals surrounding the turbine shaft. The first section flows through holes in the diaphragm and up the front face of the turbine wheel into the stream of hot gases. The second section passes along grooves through the root of the turbine wheel and out between the first and second wheels. It can then either flow behind the first stage turbine to cool its rear face or through a specially designed labyrinth seal to cool the forward face of the second wheel. Hence this source of supply cools three of the six turbine faces.

Another air supply is tapped off between the roots of the seventh-stage stators and is piped to another spider arm, from which it passes through drilled holes to a second air ring in the labyrinth seal, situated forward of the high pressure air ring. From here another set of grooves allows the air to pass through the roots of the first and second turbine wheels, so that it reaches the space between the second and third turbine wheels. Part of the air now flows up and cools the rear face of the second wheel, while the remainder filters through the labyrinth seal and cools the forward face of the propeller turbine wheel.

The rear face of the propeller turbine wheel is cooled by another supply of air tapped from the fifth stage of the compressor. This air is led to a pipe at the rear of the turbine bearing and flows up the wheel face. Besides cooling the turbine wheels, the air acts as a seal between the blade roots and the nozzles to prevent the hot gases from escaping. The passages and tappings from the compressor are so arranged that the air reaches the blade roots at a pressure slightly higher than that of the hot gases at that particular stage.



Reduction Gear

Turbine Mounting

The turbine is mounted on a ring near the rear of the compressor casing. The mounting has been designed to suit either a monocoque or a conventional supporting structure. A sheet metal sheath of cylindrical shape bolts firmly on to this ring. It encloses the compressor casing and supports the forward end of the compressor and the gear casing. The rearward end of the compressor is suspended from the main support by means of eight hinges and trunnions, thus allowing for both axial and radial expansion. The turbine section is mounted from a faired structure which bolts on to the compressor casing, providing a smooth entry into the compressor. This structure supports the turbine casing by pins passing through the arms of a spider casing. This spider casing, picking up from the structure, supports the bearings for the turbine and compressor shaft, thus accommodating expansion of the turbine and compressor sections of the engine. The effect on the turbine drive shafts is allowed for by the use of a toothed coupling, which accommodates expansion as well as any accumulation of tolerances during assembly. Longitudinal expansion of the combustion chamber is permitted by a sliding joint in the end cover of the combustion chamber, which is made gas-tight by three piston rings. Thermal expansion also causes relative movement between the combustion chambers, which is allowed for by sliding joints in the interconnecting tubes.

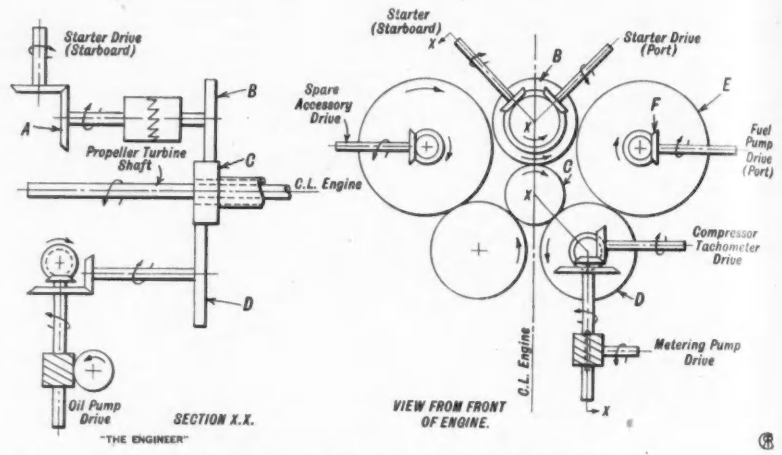


Diagram of Gear Trains for Auxiliaries

New Surveying Vessel for the Royal Navy

(By Our Naval Correspondent)

An important addition will be made to the Royal Navy's fleet of surveying ships responsible for charting the oceans of the world when H.M.S. "Owen" is accepted into H.M. service at Chatham. The "Owen" is the third surveying vessel to be completed since the war, and like her post-war predecessors, the "Dampier," now in the Far East, and the "Dalrymple," operating in the Mediterranean, she is named after a well-known surveyor, Vice-Admiral William FitzWilliam Owen. Admiral Owen was one of the founders of the Naval Surveying Service, and he was also known for work he performed between the years 1821–26 in mapping sections of the African coastline. The "Owen" is similar in design to the "Dampier" and "Dalrymple." Her dimensions are: extreme length, 307ft; length between perpendiculars, 286ft.; extreme breadth, 38ft 7in; maximum draught, 14ft 3in.

She is fitted with modern oquipment and has a peacetime complement of eleven officers and 147 men. Her Commanding Officer is Commander H. Menzies, R.N., who until recently was serving as liaison officer in the Hydrographic Department of the Admiralty, and was in charge of staff charts. The ship will be proceeding to the Persian Gulf during her first commission. H.M.S. "Owen" is powered by four-cylinder, triple-expansion, steam reciprocating engines giving a total of 5500 i.h.p. on a two-shaft arrangement. Her electrical power at 220V d.c. is derived from two 120-kW steam turbo-driven and two 150-kW diesel-driven dynamos. Her hull was built by Hall Russell and Co., Ltd., Aberdeen. That firm also manufactured her main machinery. She was launched on October 19, 1945, and completed at H.M. Dockyard, Chatham.

Unified Screw Threads

In December last, the technical Press announced the signing of a Declaration of Accord in Washington between Great Britain, the U.S.A. and Canada on a unified screw thread system. This agreement represented the culmination of discussions extending back over thirty years, and resolved differences in screw thread design which have existed for close upon a century. Since December last, the final technical details have been completed in the preparation of the national standards. The American Standards have recently been published, and the Canadian Standard is to be expected shortly. The British Standard (B.S. 1580 :.1949) has just been published.

The thread system is to be known in all three countries as the "Unified Screw Thread System," and common designations for the various threads have been agreed. The system at present relates to threads ¼in and larger for bolts, nuts, screws and engineering details; no common agreement has yet been reached regarding threads smaller than ¼in or pipe threads. The system embraces a defined thread form, two regular diameter/pitch series, namely, a coarse series and a fine series, and the appropriate tolerances for three classes of threads in the regular series and also for threads of special diameters and pitches. The form of thread is one having a 60 deg. angle. The bolt (external) thread has a rounded root with the alternatives of a rounded crest for use in the United Kingdom and a flat crest for use in the U.S.A. The nut (internal) thread follows conventional practice in having a cleared minor diameter to facilitate tapping.

Proceeding concurrently with the technical discussions between the three countries over the last four years, an extensive research on screw thread form has been conducted at the National Physical Laboratory. This research has shown that within broad limits the angle of a thread is not a feature of major significance in respect of strength. In general, the unified form is somewhat stronger than the Whitworth form, though the difference is only marked in the case of cold rolled threads. Other investigations at the National Physical Laboratory have shown that with bolts and nuts made to normal commercial tolerances, hand assembly may be anticipated between Whitworth nuts and unified bolts, and vice versa, up to about ¼in. Tests show that no loss of strength is occasioned by such "crossing," except possibly in the case of high-tensile nuts, the use of which is anyway undesirable from the strength aspect.

This newly issued British Standard furnishes all of the technical data necessary to ensure the interchangeability of threaded products made to this standard and to the corresponding American and Canadian standards. It defines the basic threadform and gives the numerical data associated with this thread form for all of the common pitches from thirty-six to four threads per inch. Complete tables of dimensions are given for the two regular diameter/pitch series, namely, the unified coarse thread series (designated U.N.C.) from ¼in to 4in diameter, and the unified fine thread series (designation U.N.F.) from ¼in to 1½in diameter. The pitches in the unified coarse series are identical with those of the B.S.W. series; those for the unified fine series are somewhat finer than the B.S.F. series. Three classes of work tolerances are given. In the fine class there is no allowance between maximum screw and minimum nut, but in the medium and free classes such an allowance is provided. The effective diameter tolerances are calculated from a three-part formula which takes account of diameter, pitch and length of engagement. This follows the practice introduced by the B.S.I. in the 1940 edition of B.S. 84 for Whitworth form threads. A new principle is, however, introduced in that in the unified system the tolerance on the nut in each of the three classes is approximately 30 per cent greater than the tolerance on the screw. Explanations are included of the various formulæ and on the relationship between the effective diameter tolerances and pitch and angle errors. The tables of tolerances for special threads are compiled in a similar manner to those in B.S. 84 for Whitworth form threads and provide for a variety of pitches on all diameters from ¼in to 20in. To assist designers, and to facilitate the economic production of both work and gauges for special threads, a schedule of preferred diameters and pitches is included, and the threads in this series are designated U.N.S. The standard includes recommendations as to the types and thread forms of gauges for inspecting the unified thread. For the convenience of users in countries in which the metric system of measurement has been generally adopted, the metric equivalents of all of the tables of dimensions and tolerances are given in an appendix.

The Standards organisations in the three countries concerned will maintain continuous co-operation for the development and extension of this standard. Discussions are already proceeding in Great Britain on the question of a unified thread system for sizes below ¼in and on the general dimensions of bolts and nuts with the unified thread. A comprehensive series of standard definitions relating to screw threads is now practically agreed between the three countries and will in due course be issued as a separate British Standard.

The present specification is issued at this stage as a provisional British Standard. It is intended that, at the end of six months it shall be reviewed in order that it may be confirmed as one of the series of British Standards for screw threads. Comments on the standard will be welcomed and should be sent to the British Standards Institution by not later than December 31st. Copies of this Standard may be obtained from the British Standards Institution, Sales Department, 24, Victoria Street, London, S.W.1, price 7s. 6d., post free.

Electrical Contracting and Retailing Policy of the B.E.A.

The British Electricity Authority has now declared the policy to be adopted by the nationalised industry towards electrical contracting and retailing. Trading activities by the fourteen area electricity boards will be conducted on fair and unsubsidised commercial lines and on the basis of "good relationship" with private electrical contractors, to allow healthy competition between the boards and private contractors for the benefit of electricity consumers.

The Electrical Contractors' Association (Inc.) and the Electrical Contractors' Association of Scotland have been advised of the Authority's opinion that there should be no restrictions on the contracting activities of electricity boards, contracting being regarded as an essential part of the services which consumers expect to receive from the electricity supply industry. Healthy competition, the B.E.A. believes, would be beneficial both to the electricity boards and to contractors. To that end the contracting departments of the electricity boards should be run on a sound commercial basis with a proper allocation of costs and the fullest co-operation should be maintained to secure close and friendly relationships between the electricity boards and contractors and the electrical contractors' associations.

Arising from this declaration of policy, the electricity boards, the Electrical Contractors' Association (Inc.) and the Electrical Contractors' Association of Scotland have mutually agreed the definition of certain general principles to guide the future trading relationships of all electrical contractors, including the electricity boards.

These principles include the following provisions and it has been agreed that their application shall, where desirable, be discussed locally between the boards and the private contractors.

Installation Contracting.—In tendering and charging for contracting work, all costs, including labour, materials and overheads, will be assessed on a fair, commercial basis. It is recognised that complete uniformity of procedure, particularly in the assessment of overheads, is impracticable. Freedom of action must be preserved to buy in the best market at the best terms possible, and to take deliveries at any desired place.

Retail Sales.—Full list prices will be charged for retail sales, subject to the provisos that this clause shall not exclude the right to sell bad stock at reduced prices, and that discounts as provided by the "Electrical Industry Fair Trading Policy" may be allowed to local authorities and other purchasers entitled to them.

Hire purchase and credit facilities will be based on sound economic and commercial lines.

Inter-trading between electrical contractors, including electricity boards, will be a matter for mutual arrangement ad hoc.

Hiring.—Except in cases already covered by existing agreements the charges for hire of domestic apparatus of low current consumption or low initial cost, e.g., refrigerators, fires, kettles and irons, will allow for all costs, including maintenance, where applicable, during the period of hire.

Extension to Mains and New Developments.—Upon application, area boards will normally accord full information to contractors as to projected mains extensions within such contractors' districts at such time as will enable them to participate in the development of the localities to be supplied by such extensions.

Conference on Foundry Steel Melting

The British Iron and Steel Research Association announces that its Steel Castings Division is organising a Conference on Foundry Steel Melting, which is to be held at Ashorne Hill, Leamington Spa, on Thursday and Friday, September 22nd and 23rd. The conference will consist of four sessions, two on each day, and the programme is being arranged to permit ample time for discussion. At the first session "The Cupola-Converter Process" will be considered, and the papers to be presented are "Its Scope and Limitations," by Mr. F. Cousans; "The Design of Converters," by Mr. A. G. Robiette; "Controlling Sulphur and Phosphorus Contents," by Mr. A. J. Langner; and "Application of Oxygen Enrichment," by Dr. W. C. Newell. The subject for the second session is "The Electric Arc Process," the papers being "Its Specialised Control and Use," by Mr. J. H. Pearce and Mr. W. Bramhall; "Refractories for Electric Furnaces," by Dr. J. R. Rait; "Electrical Characteristics, Output and Design of Arc Furnaces," by Mr. J. C. Howard, and "Steel Foundry Productivity," by Mr. F. A. Martin. At the third session, "Other Melting Processes" will be discussed, the papers including "Foreign Practice," by Mr. A. C. Brearley; "The Use of the H.F. Process in Foundries," by Mr. C. McNair, and "The Use of the Open-Hearth Process in Foundries," by Mr. J. Mowat. The final session will be devoted to the consideration of "General Items," discussion being based on papers on "The Fluidity of Different Steels," by Mr. J. E. Worthington; "The Cost of Melting in Factories," by Mr. F. N. Lloyd, and "Specifications for Steel Castings," by Dr. E. Gregory.

Mr. Richard Lamb, research metallurgist of Hadfields, Ltd., will preside over the conference, application forms for which can be obtained from the British Iron and Steel Research Association, 11, Park Lane, London, W.1.

Valve Holders for Miniature Valves

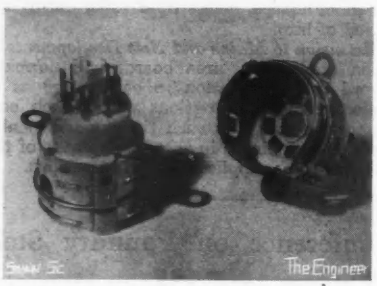
Two new valve holders have recently been introduced by the Plessey Company, Ltd., Ilford, Essex, to accommodate the miniature valves which are being increasingly widely used in all branches of electronic engineering. Both holders are designed for two-hole fixing.

One of these new components, the "B 8 A" ceramic valve holder, is illustrated in the illustration overleaf, which shows two

views of the holder. The various socket cavities in the one-piece ceramic moulding are isolated from each other without the possibility of the formation of moisture traps. Test results after humidity testing indicate that the ceramic moulding has an insulation resistance of 4000 megohms between sockets, and between sockets and the central earth connection. The capacitance value is stated to be approximately 0·1 to 0·2μμF between pins and 0·1 to 0·15 measured from all pins together to earth.

A tinned screening base, which is provided with a locating key to ensure correct insertion of the valve, also serves to earth the valve base to the chassis. Where there is considerable vibration a retaining spring of cadmium-plated steel wire can be supplied as an optional component to anchor the valve in position.

The retention force on each contact socket, even with minimum-tolerance pins, is approximately 4oz. When the retaining spring is used



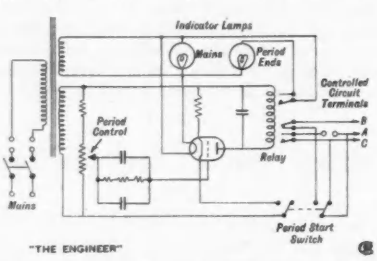
B8A CERAMIC VALVE HOLDER

the extraction force is 10 lb for spigot valves and 8½ lb for non-spigot valves, the corresponding values without the retaining spring being 3 lb and 2 lb. Fully floating nickel-silver sockets designed with smooth, low-angle lead-in give considerable resilience and minimise the possibility of damage to valve-pin seals.

The other new valve holder, the "B 9 A," is made of laminated plastic and is designed primarily for domestic use for the new miniature nine-pin valves now becoming available. In general design this valve holder resembles the Plessey "B 7 G" and "B 8 A" holders, except that it consists of two plates of synthetic resin-bonded paper held together by means of a central socket spun over the top plate after assembly. The silver-plated phosphor-bronze pin sockets are of the "pen nib" type, split and formed to give a springy high-pressure connection when the valve is inserted, and fitted with extended tags for easy soldering. The construction is such that the possibility of moisture traps between adjacent pins is greatly reduced. Although a high contact pressure of approximately 5oz with minimum size pins is obtained, the shape of the contact and the generous lead-in allows the valves to be inserted and withdrawn with ease.

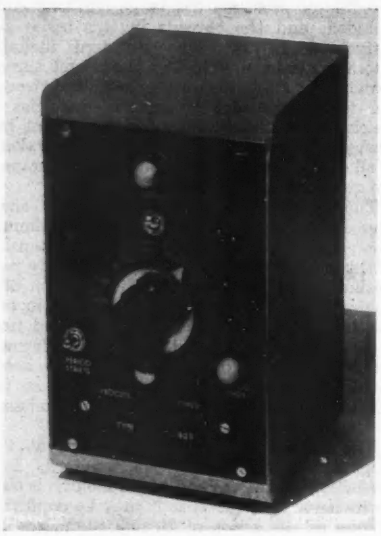
An Electronic Process Timer

AN electronic process timer designed and manufactured by Airmec Laboratories, Ltd., High Wycombe, Bucks, should find a useful



CIRCUIT DIAGRAM OF ELECTRONIC PROCESS TIMER

field of application in industries where accurate timing of repetitive processes is necessary to ensure uniformity of product with unskilled labour, or to allow the process sequences to be automatically controlled. As illustrated herewith, the "Airmec" process timer is compactly housed in a grey metal case with a black anodised aluminium panel, carrying the indicating lamps and controls which provide a range



"AIRMEC" ELECTRONIC PROCESS TIMER

of operation from 10 to 180 seconds. The instrument is suitable for bench use or for mounting directly on equipment such as r.f. heaters, machine tools, &c.

A timing accuracy of ±10 per cent of the selected time period is claimed, but it is pointed out that the repetition accuracy (which is generally of greater importance than the absolute accuracy) is much better than ±10 per cent. The accuracy is stated to be independent of the supply voltage provided there is no variation during the timing period.

Referring to the accompanying circuit diagram, the principle of operation is as follows:—Operation of the "Start" switch starts the timer by completing the work circuit. After a certain time interval, which depends on the setting of the period control, the valve "fires" and operates the contacts of the electromagnetic relay in the anode circuit. The output connections from the relay for time-control purposes provide either open circuit operation (from terminals *A* and *B*) or closed circuit operation (from terminals *A* and *C*). At the same time, closure of the upper pair of contacts causes the green lamp to light up, indicating the end of the timing period.

The timing period is proportional to the product of the capacitance and resistance in the period control circuit associated with the valve grid. By adjusting the potential divider supplying the valve grid, the time interval can be set to any value within the range of the instrument, the dial of which is calibrated in seconds. On completion of each timing cycle the period start switch should be returned to the "Off" position in readiness for the process to be repeated.

The relay contacts can be arranged to control any external circuit either directly or through a contactor if the load current is large. The specified capacity of the relay contacts is 3A at 250V. Protective fuses are connected in the mains input and work output circuits, and renewal can be carried out by removing the nameplate from the front panel without having to disconnect the instrument or remove it from its case. Above the mains switch is a red pilot light to indicate when the unit is switched on.

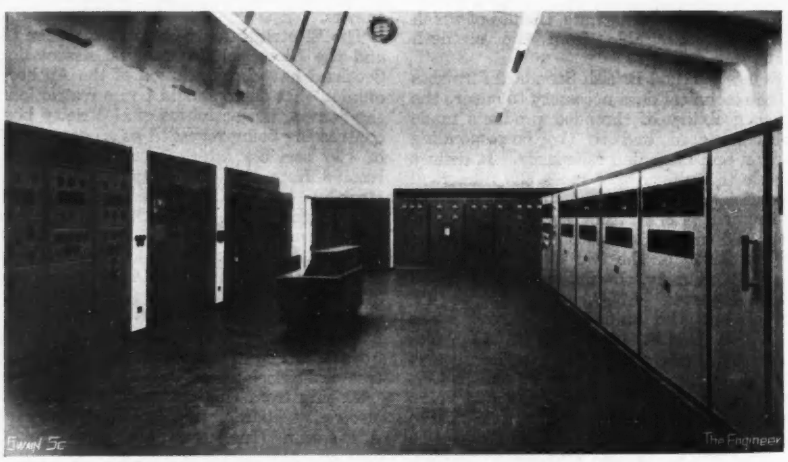
Broadcasting Developments in Sweden

FOLLOWING its progressive policy of improving the medium-wave broadcasting service in Sweden, the Swedish Broadcasting Administration is in the process of replacing some of its old transmitters by more up-to-date high-power equipment. As a result, improved service areas will be obtained for the 6·84 million inhabitants, who are spread over a superficial area of nearly half a million square kilometres, and amongst whom there are more than two million radio licence holders.

Of three high-power transmitters ordered from Standard Telephones and Cables, Ltd., Connaught House, Aldwych, London, W.C.2, two have recently been put into service—a 150-kW station at Sundsvall in the north, and a 100-kW at Hörby, in the extreme south of Sweden. The third transmitter for Göteborg on the west coast is scheduled to be in operation next year.

The new "Standard" "CM 9" 100-kW equipment at Hörby replaces an old design of transmitter of low efficiency. It is interesting to note that the "CM 9" installation is accommodated inside the old transmitter, the latter being left in a working condition as a spare. This fact strikingly demonstrates the progress made in recent years in the design of compact transmitters.

At Sundsvall a 10-kW "Standard" transmitter has been in continuous service for twenty years and has now been replaced by the 150-kW "Standard" transmitter type "CM 7 B," as illustrated herewith. Working on a frequency of 601kc/s and with an overall efficiency of 41 to 43 per cent, the audio-frequency range distortion is less than 2 per cent up to 90 per cent modulation. Part of the equipment is a complete 2-kW transmitter which may be used either as a spare or may be switched in instantly during programme in place of the working exciter. The transmitter power at Sundsvall can readily be increased to 180kW.



INTERIOR OF SUNDSVALL 150kW BROADCASTING STATION

American Engineering News

Shell to Build Pipe-Line

A 10in pipe-line is to be constructed by the Shell Pipe Line Company, a subsidiary of the Shell Union Oil Corporation, from the Elk City oilfield in Oklahoma to Cushing, a distance of approximately 160 miles, and is estimated to cost nearly 4 million dollars. The new pipe- line will have a capacity of 24,000 barrels of crude oil a day.

Ship with Twin Hulls

A considerable amount of publicity is being given to an unconventional type of ship design evolved by Mr. Gar Wood, the well-known speedboat racer, who, it is stated, has spent twenty-eight years on its development. The basic idea is to have twin hulls to provide the catamaran principle for maximum stability. Mr. Wood has put the idea into practice by building a vessel called the "Venturi," which is 188ft long and 40ft wide, with a broad deck connecting the two hulls about 22ft above the water line. The ships seen head-on, looks like a large square-sided tunnel. Powered by four 1200 h.p. G.M.C. diesel engines, it cruises at 26 knots, drawing only 6in of water at the bow and 8ft at the stern. The hulls broaden on the inboard side towards the stern to give a venturi effect, hence the name of the vessel. It is suggested that air rushing through the tunnel buoys up the ship and serves also as a shock absorber for any up and down movement of the vessel.

TWIN-HULL VESSEL "VENTURI"

New Mississippi Bridge

The seventy-fifth anniversary last month of the Eads Bridge across the Mississippi River at St. Louis added interest to the work which is now well under way on the substructure of the new bridge, which the Massman Construction Company and the Kansas City Bridge Company are building, two blocks northwards of the old bridge. The new bridge, on which work was started in September, 1948, will be a continuous steel truss structure having a centre span of 962ft and two side spans of 470ft. It is designed to carry a single roadway 40ft wide. The river piers for the bridge are being built almost entirely with the aid of floating equipment, the principle components of which are two derrick barges, one 44ft by 80ft and the other 40ft by 60ft, each of which has a 100ft derrick. River pier 9, which is now nearing completion, contains nearly 3900 cubic feet of concrete and was built in an open coffer-dam measuring 40ft by 80ft. Work on the longest pier, No. 10, which is situated well out in the river, is being delayed until all danger of high water is past. Pier 11 is based on solid rock about 90ft below low water and is composed of two cylinders, each 30ft in diameter at the base and tapering to a rectangular section, 14ft by 20ft at the top. These two shafts, which are connected by a web wall extending below the water line, were placed by open dredging methods until hard rock was reached.

Diesel Generating Plant

A diesel-electric generating plant designed for a total capacity of 30,000kW, has recently been put into service at Tacubaya, Mexico City, for the Mexican Light and Power Company. The plant has six Nordberg twelve-cylinder diesels rated at 8650 b.h.p. each, although, due to the 7600ft elevation of the station, the rating is brought down to 7350 b.h.p., which corresponds to a net rating of 5150kW for each generator installed. The generaters were built by General Electric and are of the three-phase, 50-cycle type, designed for an output of 7500kVA, 6000kW, at 167 r.p.m. The Nordberg engines have cylinders of 29in bore and 40in stroke, and are of the single-acting, two-stroke type. The total daily fuel consumption of the six units is some 80,000 U.S. gallons. Fuel storage capacity at the station totals 800,000 gallons and to aid circulation water heating coils are carried in each of the twelve 36in diameter Burgess-Manning mufflers, which are installed on the roof of the generator hall. There is one exhaust muffler for each block of six cylinders.

Rebuilding by Units

New England's largest department store, covering a whole city block in the heart of Boston, Mass., is being entirely rebuilt on a unit system without any interference with business. The present store covers an area 360ft long by 250ft wide and comprises a series of buildings of varying ages and types of construction. They are being replaced with a new seven-storey building having two basements, which will be constructed in five separate sections. The design is such as to enable the structure to reach a height of thirteen storeys if needed. The first replacement section, which is expected to be completed in September, covers an area of about 250ft by 100ft at the south end of the block. As the foundation extends about 35ft below the level of the street, the rest of the store along one side of the elevation had to be supported by sheeting and bracing, as were also the banks of the streets on the other three sides, together with a subway and station. The foundation consists of a thick reinforced concrete mat covering the entire area. Excavation for the foundation, the placing of the heavy steel bracing, and the pouring of the concrete mat were carried out from three temporary steel trestles erected over the site. The unusual condition that the work could not interfere with normal business operations of the adjoining portions of the store, together with the deep foundation work and necessary underpinning was further complicated by the very restricted area available for construction operations. The adjoining streets of the section are narrow, yet carry extremely heavy traffic. Two main subways of the Metropolitan Transit Authority also run under these streets and cross at their intersection.

Temporary concrete footings were constructed inside the south building line of the existing store along the length of the Unit No. 1 site and a steel framework was erected above the footings to support the floor joists, which had been held up by a masonry bearing wall. The entire width of the store was then closed in at this framework, for the full height, with a partition of studding, sheeting, insulating paper and asbestos shingles. The joists projecting beyond the framework were cut off, and the entire bearing wall, which was 4ft thick at the bottom, was then removed.

Gas Turbine Locomotives

Following the success of track trials in the Eastern states, which have been carried out on the Erie Railroad, the experimental Alco-G.E. gas turbine locomotive, completed last November, is to undergo more stringent tests in the mountainous Western districts. These latest tests will be conducted by the Union Pacific, which will employ the unit on heavy freight haulage. With a total weight of 500,000 lb, this joint product of the American Locomotive Company and General Electric has a continuous tractive effort of 68,500 lb at 25 m.p.h. and is geared for a maximum speed of 79 m.p.h. The gas turbine unit is rated at 4800 b.h.p., of which 4500 b.h.p. is available for the generator drive.

Rubber for Highways

In a statement made following the laying of a new rubber road section near Columbiana, Ohio, Mr. Harvey S. Firestone, Jr., chairman of the Firestone Tyre and Rubber Company, said that this was likely to open large new fields for the consumption of both natural and synthetic rubber. It might also have favourable international economic results, as it would help to supply Great Britain, Holland and France with more dollars in exchange for rubber without interfering with the operation of the U.S.A.'s national defence synthetic rubber plants. Mr. Firestone claimed that his company's laboratory and highway tests, supplemented by extensive Far East and European experiments, indicated that the use of rubber powder in asphalt mixtures greatly improved the durability of "black-top" highways, and reduced maintenance costs. Such roads had been laid in Ohio, Virginia, Minnesota and Texas, and were being considered by other states. The new rubber road section was laid on State Route 14, near Columbiana, Ohio, a heavily travelled truck route. Powdered rubber was mixed with asphalt topping material, then spread over the road surface by standard types of road-making equipment.

Huge Reclamation Programme

Addressing the annual conference of officials of the Bureau of Reclamation, held in Boulder City, Nevada, this week, Mr. Michael W. Straus, Commissioner of the Bureau, said that appropriations for the next fiscal year's activities of his department might total 350,000,000 dollars. He based the figure on requests made by the Bureau and on indicated action of the House and Senate. The budget this year was 300,000,000 dollars. The nation and Congress were calling on the Bureau of Reclamation to complete a programme beyond anything ever attempted.

Industrial and Labour Notes

The T.U.C. Agenda

The eighty-first Trades Union Congress begins at Bridlington on Monday next, under the presidency of Sir William Lawther, and during last week the final agenda was circulated to delegates. It is divided into nine sections and contains in all sixty-seven resolutions which are to be submitted by affiliated unions. As was to be expected, the two largest sections of the agenda are those dealing with profits, prices and wages, and with industrial policy and organisation. On the first of these matters, in addition to the resolutions set out in the agenda, the T.U.C. Economic Committee has prepared a special report which is now being circulated to affiliated unions, and which will no doubt be fully discussed when next week's congress debates economic affairs.

The principal resolution on economic matters has been framed by the T.U.C. General Council, and states that "a permanent solution of the nation's difficulties can only be found, internally, in a greater volume of production at lower costs, with a consequent raising of the purchasing power of wages, and, externally, in internationally concerted efforts to maintain living standards and full employment." A later part of the resolution pledges "continued support of the policy aimed at securing the greatest possible measure of restraint in seeking to increase personal incomes and expenditure unrelated to increased productivity." Resolutions submitted by various unions indicate some measure of support for the T.U.C. economic policy, although one to be put forward by the Amalgamated Engineering Union urges the General Council to approach the Government "with a view to restricting increased profits by legislation and to taking more effective action to control and reduce prices, profits and heavy distribution costs." A somewhat similar resolution comes from the National Union of Railwaymen, which expresses "alarm at the increase in the cost of living," and suggests that the Government should be pressed "to take vigorous action with a view to effecting substantial reductions in prices and profits."

Nearly all the resolutions on "industrial policy and organisation" deal with the nationalised industries. One from the Transport and General Workers' Union voices concern at the composition of many of the boards of nationalised industries, both at national and regional level, and "affirms the principle that appointments to the boards should be drawn from people of proved ability, not by way of applying a political test, but strictly on the basis of experience, ability and capacity to administer the nationalised industries." It also urges that extensive training schemes should be introduced "so as to provide every opportunity to the workers in the nationalised industries to develop technical knowledge and administrative ability of a type which will fit them for the duties and responsibilities of management." One resolution—from the Amalgamated Union of Foundry Workers—advocates the nationalisation of the main sections of the founding and engineering unions. It puts forward this proposal in the belief "that a planned economy is the surest guarantee of full employment, stability at home, and peaceful relations with other countries." The Amalgamated Engineering Union has tabled some amendments to the resolution, recommending a full examination in order to determine which sections are appropriate for nationalisation; in which sections it would be appropriate to establish development councils, and "in which sections it would be appropriate to establish non-statutory advisory bodies representative of management and workpeople."

Changes in Wage Rates

A few days ago, the Ministry of Labour published particulars of the changes in rates of wages which came into effect during the month of July. They resulted in an aggregate increase of about £133,000 in the weekly full-time wages of 607,000 workpeople. Among those involved in the changes were workers in some sections of the iron and steel industry, coke manufacture, ironstone and limestone quarrying, heavy chemical manufacture, and in heating, ventilating and domestic engineering.

The Ministry's statement adds that in the first seven months of this year, to the end of July, changes in wage rates resulted in 4,364,500 workpeople receiving increases totalling approximately £750,500 a week. In the corresponding months of 1948 there were net increases in the weekly wages of 4,508,500 people, totalling £1,127,900.

Trade Disputes

According to the *Ministry of Labour Gazette*, fifty-nine stoppages of work through industrial disputes were reported as beginning during July. In addition, thirteen stoppages which began before July were still in progress in the early part of that month. The Ministry says that in these seventy-two stoppages 24,100 workpeople were involved directly or indirectly, during July, with an aggregate loss of 265,000 working days. In the coal mining industry there were forty stoppages through disputes in progress in July, and in them 4100 workers were concerned with a resulting loss of 6000 working days. Thirteen stoppages, involving 900 workers, occurred in the metal, engineering and shipbuilding industries, and a loss of 3000 working days was incurred. The biggest proportion of working days lost, however, was in the port transport industry. In the London docks an unofficial strike began on June 23rd and was continued until July 23rd. In all, 15,650 workpeople were involved.

An analysis of the first seven months of 1949 shows that there were 883 stoppages of work through disputes reported to the Ministry of Labour. The total number of workers affected by them is put at 255,200 and the aggregate number of working days lost was 1,189,000. In the comparable months of last year there were 1139 stoppages in which 325,700 workers were concerned and through which 1,607,000 working days were lost.

Distribution of United Kingdom Trade

In the current issue of the *Board of Trade Journal* particulars are given of the distribution of United Kingdom trade in the second quarter of this year. It is shown that during the quarter there was a fall of one-quarter in the value of exports to the Western Hemisphere to £57,300,000, which figure represented 12·82 per cent of the total, compared with 16·04 per cent in the preceding quarter.

Reductions in exports of agricultural tractors, cars and non-ferrous metals and in re-exports of rubber are said to be the principal cause for a decline of two-fifths in the total value of exports to the U.S.A. in the second quarter. The proportion of British exports taken by that country was 2·29 per cent, compared with 3·68 per cent in the first quarter of this year and 4·25 per cent in the last quarter of 1948. Exports to Canada increased slightly during the second quarter and amounted, in value, to 4·45 per cent of the total, compared with 4·25 per cent in the first quarter of the year. The sterling area as a whole took a larger share of the United Kingdom's exports during the second quarter, the figure quoted being 53·43 per cent, compared with 50·07 per cent in the first quarter. There was, however, little change in the value of exports to the sterling area, the total reached being about £239,000,000. The proportion of exports to European countries in the second quarter was 28·01 per cent, which was a little above the first quarter, although the value declined from £131,900,000 to £125,300,000.

The Board of Trade has also stated in the last few days that the index of import prices (1947=100) fell from 115 in June to 113 in July; the latter figure is the lowest recorded since April, 1948. The index for raw materials declined two points during the month, but prices in July were, nevertheless, 23 per cent above the 1947 level. For imported manufactured goods, the index number fell during July to 110, which was one point below that for June. The price index for total exports showed no change during July and at 113 was one point higher than the April number.

The Institute of Industrial Supervisors

The Institute of Industrial Supervisors has recently formed an educational advisory panel to guide activities concerned with improving the efficiency of industrial supervision. The purpose behind this development, the Institute says, is to keep educational activities on a practical level and to assist both the established and trainee foreman and supervisor.

The Panel's terms of reference will certainly enable a wide field to be covered. They include: advising the Institute's council on all matters relating to organised educational activities in foremanship and supervision; surveying existing educational facilities and courses available to foremen and supervisors; making recommendations about courses to be sponsored or recognised by the Institute; considering the award of an Institute certificate for the successful completion of an approved course, and the possibility of such a certificate being an educational qualification for graduate membership of the Institute; recommending syllabuses for "refresher" courses; maintaining liaison with industry, the Ministry of Education, the British Institute of Management and other professional bodies, and considering the award of prizes for papers. The members of the Panel are Sir Anthony Bowlby, director of Guest, Keen and Nettlefolds, Ltd.; Mr. Michael Clapham, personnel director of the Metals Division, Imperial Chemical Industries, Ltd.; Mr. E. W. Hancock, M.I. Mech. E., director and general works manager of Humber, Ltd., and Mr. David Bramley, A.M.I. Mech. E., Central Technical College, Birmingham.

The Institute of Industrial Supervisors has also announced the first of a series of week-end residential courses for foremen and supervisors. It is to be held at Primrose Hill, Birmingham, on September 16th, 17th and 18th, the inclusive charge being £2 10s. Full particulars of the course are obtainable from the general secretary of the Institute, Bank Chambers, 47, Temple Row, Birmingham.

Trade Unions and the Economic Situation

As we go to press, there has just been issued the T.U.C. Economic Committee's supplementary report which is referred to in the first of these notes. The report, which will come before the Trades Union Congress at Bridlington next week, sets out the T.U.C. policy on economic matters, and discusses some of the problems at present confronting the United Kingdom and the British trade union movement.

Among its conclusions on these matters, the T.U.C. General Council says that it would be failing in its duty if it did not make it unmistakably clear that there is no possibility of securing any wide and sweeping price reductions as long as the economic situation remains what it is in the world at large. The report goes on to point out that the general level of wages has considerably improved, prices have been kept stable, the cost of living has been kept in close approximation to the means of the average wage earner, expenditure on social services is repaid in real benefits to the bulk of the population and especially to the wage earners, the number of people employed has never been so high, and that the number of unemployed has never been so low.

At this stage, the report adds, a more general increase in money wages could not bring idle resources into production and would, therefore, fail to give a higher standard of living than at present. A substantial increase in money wages would, in fact, it is suggested, intensify both our internal and external difficulties and thereby have an adverse effect upon the general standard of living.

French Engineering News

(From our French Correspondent)

Latest figures for automobile production in France show that 16,880 private cars were produced in May, 1949, compared with 15,120 in April, and the 1938 average of 15,200; 9252 industrial vehicles in May, 1949, compared with 8961 in April and 3280 (1938 average); 211 vans, compared with 197 in April; 115 tractors, compared with 118 in April, giving a total of 26,458 in May, 1949, against 24,396 in April, 1948, and 18,950 in 1938.

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Brazilian orders placed in France cover locomotives and oil refineries. The Groupement d'Exportation de Locomotives Gelsa, which comprises Cail, Fives-Lille, Locomotives Batignoles-Chatillon, and Schneider, has signed a contract at Rio de Janeiro for ninety steam locomotives specially designed to suit Brazilian railways. At the same time, equipment for Brazil's first large oil refinery is to be constructed by France. Installations will be capable of treating a minimum of 45,000 barrels of crude oil daily and the refinery will produce 91 octane aviation spirit, 76 octane motor spirit, and diesel oils for combustion as well as liquid commercial propane. The installation is part of a big five-year programme. The locomotives and refinery orders represent about 21 million dollars, or almost 7 milliard francs, which will cover the French commercial deficit for the past five years.

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A mechanism constructed by the Ets. Goulliart is claimed to make it possible for all types of steam roller to be drawn by a tractor or lorry at speeds up to 45km an hour. The device consists essentially of wheels fitted with rubber tyres which can be raised when the steam roller is working and lowered when it is to be moved so as to carry the whole of the machine. The wheels are raised or lowered by hydraulic jacks, worked by a hand pump in the cabin. Two of the wheels, placed behind the roller, are controlled by a single jack to form a steerable fore-carriage, fitted with a drawbar. Two pairs of coupled wheels placed in front of the roller are carried by an axle which can be lifted or lowered by two jacks and guided by slide rods. It is understood that the raising or lowering of the set of rubber-tyred wheels takes less than ten minutes. The axles are fitted with Bendix-Lockheed brakes which can be controlled by hand or foot from the roller or from the lorry by which it is towed.

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The Société des Docks et Entrepôts du Havre is shortly to bring into service a 12,500 square metre unloading hangar, and warehouses covering about 11,300 square metres. Travelling cranes will be installed throughout. The structures are part of the war reparations programme which is being spread over three years and for which 300 million francs will be initially spent.

* * *

Deliveries in 1948 of iron ore from French mines were 25,230,396 tons, compared with 18,223,593 tons in 1947. Out of this tonnage the internal market absorbed 16,508,639 tons in 1948 and 11,937,380 tons in 1947. It will be seen that there was a considerable increase in deliveries in 1948, both for the internal market and for export. Exports, however, have still not regained for France her pre-war position. Altogether, 8,721,757 tons were exported in 1948. Stocks held in December, 1948, amounted to 6,022,392 tons, against 8,255,379 tons in December, 1947, a drop of 2,232,987 tons. Geological research continues in order to extend as far as possible existing seams, and the mines are continuing to instal mechanical loading and handling equipment.

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A delegation received by the Minister of Transport has told him of the disastrous consequences to private industry resulting from the blocking of S.N.C.F. credits, particularly for the repair and construction of rolling stock. The Minister informed the delegation that orders passed by the S.N.C.F. were at the moment being considered and credits to enable them to be executed would be available for most of them.

Notes and Memoranda

Air and Water

"Python" Aero-Engine Type Test.—We learn that the Armstrong Siddeley "Python" propeller-turbine aero-engine has successfully completed an official 150-hour combined military and civil type test at a rating of more than 4000 equivalent s.h.p. This makes the "Python" the world's most powerful single aero-engine to be type-tested.

Bermuda Air Agreement, 1946.—The Ministry of Civil Aviation announces that a delegation from the United States, headed by Mr. Oswald Ryan, vice-chairman of the Civil Aeronautics Board, and Mr. Paul Barringer, of the State Department, has just concluded a visit to this country for informal discussions with the Ministry of Civil Aviation on the working of the United States/United Kingdom Bermuda Agreement of 1946. Among the specific questions discussed were the requirements of both parties for additional routes on which to extend air transport operations, and various problems connected with the procedures for determining tariffs. These discussions are in line with the provision for continuing collaboration for which the Bermuda agreement provided. A United States delegation last visited this country for similar discussions in August, 1946, and a United Kingdom delegation visited Washington for similar informal discussions last year.

Miscellanea

Cast In Situ Piling.—We have received from West's Piling and Construction Company, Ltd., Columbia House, Aldwych, London, W.C.2, an illustrated booklet entitled "West's Piling System." It contains a description of the special characteristics of West's cast in situ piles, and the plant used in driving them, together with examples of several structures where these piles have been used.

Vokes Ernst Scientific Surgical Appliances, Ltd.—This subsidiary of Vokes, Ltd., has concluded arrangements for the purchase of the artificial limb business hitherto carried on by Desoutter Brothers, Ltd., Hendon. The plant, tools, drawings and stocks of materials are now in process of being transferred from Desoutter Brothers, Ltd., Hendon, to the premises of the new company at Alton, Hants.

The Louis Edward Levy Medal.—The Franklin Institute of Pennsylvania announces the award of the Louis Edward Levy Medal to Mr. Alan S. FitzGerald in connection with a series of papers dealing with the design criteria of non-electronic amplifiers. Mr. FitzGerald, who is on the staff of the General Electric Company of America, received his engineering training at the City and Guilds (Engineering) College, London.

Nickel Properties and Applications.—A new publication in the series dealing with the properties and applications of alloys has been published by Henry Wiggin and Co., Ltd., Birmingham. It is entitled "Nickel—Properties and Applications," and includes data on the mechanical properties of nickel and its corrosion-resistant qualities. It also makes reference to a number of applications with typical illustrations of equipment in various fields.

Anglo-American Productivity Council.—The Anglo-American Council on Productivity has announced that a productivity team from the British internal combustion engine industry will sail for the U.S.A. on the "Queen Mary" on October 7th. Mr. J. R. Bergne-Coupland, works manager of Ruston and Hornsby, Ltd., will act as leader of the team, and Mr. H. Cowper, of the British Internal Combustion Manufacturers' Association, will act as secretary.

The Late Mr. H. C. Price.—We have learned with regret of the death of Mr. H. C. Price, which occurred at Birmingham on August 28th. Mr. Price, who was sixty-two, was manager of the Birmingham sales office of George Ellison, Ltd., by which firm he had been employed since 1919. Prior to that he was on the staff of the Metropolitan-Vickers Electrical Company, Ltd., having served his apprenticeship with the old British Westinghouse Company, Ltd.

Hemel Hempstead New Town.—The Hemel Hempstead Development Corporation has prepared a report to accompany the outline plan for a new town, which has been submitted to the Minister of Town and Country Planning. The designated area for the new town is 5910 acres, and the scheme envisages increasing the existing town of 22,000 inhabitants to one of a balanced population numbering 60,000. Among the matters mentioned in the Development Corporation's report is that consideration has been given to a scheme of district heating for the new town as a whole. In view of the amount and type of existing development, however, that proposal has been abandoned, although schemes of district heating for the new industrial area, the town centre, and parts of the residential area are being studied. Another matter referred to in the report is the intention to retain the existing section of the Grand Union Canal as a through route. It is hoped to increase the use of the canal by the construction of new wharves at Apsley. An exhibition of the plans for the new town was opened at Hemel Hempstead on August 13th.

A Diamond Jubilee Issue.—We have recently received the Diamond Jubilee issue of the Ohio State University's College of Engineering *Engineering Experiment Station News*, dated June, 1949. The issue contains the papers presented by the Guest and Faculty speakers during the College of Engineering's Diamond Jubilee Celebration, held from January 23 to January 29, 1949, marking the seventy-fifth anniversary of the founding of the College in 1873. The College was then known as the "Ohio Agricultural and Mechanical College."

The Austin Motor Company, Ltd., and Crompton Parkinson, Ltd.—These companies announce that, through their joint subsidiary company, Austin Crompton Parkinson Electric Vehicles, Ltd., they have acquired control of I.T.D., Ltd., of Stacatruc House, 142, Sloane Street, London, S.W.1. Mr. L. P. Lord, chairman and managing director of the Austin Motor Company, Ltd., has been elected chairman, and Colonel Raymond T. Hartmann will continue as managing director of I.T.D., Ltd. I.T.D., Ltd., is the sole world distributor of the petrol-driven range of British industrial fork-lift trucks and ancillary materials-handling equipment marketed under the trade names "Stacatruc" and "Aerolift."

Royal Photographic Society's Exhibition.—The President of the Royal Photographic Society, Mr. Percy W. Harris, F.R.P.S., will open the Society's ninety-fourth Annual Exhibition of Photography at 3 p.m. on Thursday next, September 8th, at 16, Princes Gate, London, S.W.7. For this year's exhibition, 5300 entries were received, of which 863 have been accepted. Limitations of space in the Society's House make it necessary to divide the exhibition into the following two parts:—Part 1: Pictorial, colour and stereoscopic (prints and transparencies), Friday, September 9, to Sunday, October 2, 1949, inclusive; Part 2: Scientific, nature, record and technical (prints and transparencies), Saturday, October 8th, to Wednesday, October 26th, inclusive.

Courses in Photoelasticity.—Two courses in photoelasticity are being arranged in the forthcoming session at University College, Gower Street, W.C.1. The first will deal with the practical application of photoelastic methods to the investigation of stress distributions, and will consist of fifteen lectures and demonstrations to be given on Mondays from 5 to 6.30 p.m., beginning October 10th. The second course will consist of fifteen lectures on the theory of the photoelastic method of stress analysis, including the application of the method to three-dimensional stress distributions. These lectures are to be given on Thursday evenings from 5 to 6.30 p.m., beginning on January 19, 1950. The fee for each course is seven and a half guineas, and students wishing to attend are asked to communicate with the Secretary of University College.

Blasting (Castings and Other Articles) Special Regulations.—On March 18th last, the Minister of Labour published draft regulations, entitled the Blasting (Casting and Other Articles) Special Regulations, 1949, and gave notice, in accordance with Section 129 of the Factories Act, 1937, and the Second Schedule to that Act, of his intention to make special regulations as in that draft. Certain objections were made to the draft regulations and the Minister has now directed an inquiry to be held and has appointed Mr. V. R. Aronson, K.C., as Commissioner for the purpose. The inquiry will be held in public and any objector and any other person who, in the opinion of the Commissioner, is affected by the draft regulations may appear at the inquiry either in preson or by counsel, solicitor or agent. The Commissioner will open the inquiry at the Ministry of Labour, 8, St. James's Square, London, S.W.1, at 11 a.m. on September 22nd. It is requested that notification be given to the Commissioner not later than September 15th of any persons or representatives likely to appear. Communications may be addressed to Mr. J. L. Edwards, Ministry of Labour and National Service, 8, St. James's Square, London, S.W.1, who is acting as secretary for the inquiry.

Forthcoming Engagements

Secretaries of Institutions, Societies, &c., desirous of having notices of meetings inserted in this column, are requested to note that, in order to make sure of their insertion, the necessary information should reach this office on, or before, the morning of the Monday of the week preceding the meetings. In all cases the TIME *and* PLACE *at which the meeting is to be held should be clearly stated.*

Aslib.

Fri., Sept. 9th, to Mon., Sept. 12th.—Annual Conference at Ashorne Hill, near Leamington Spa, Warwickshire.

Engineering and Marine Exhibition

To-day, Sept. 2nd, to Sat., Sept. 10th.—Olympia, London.

Incorporated Plant Engineers

To-day, Sept. 2nd.—BIRMINGHAM BRANCH: Imperial Hotel, Temple Street, Birmingham, "The Preparation of Granite for Roads," C. G. Kitchingman, 7.30 p.m.

Tues., Sept. 6th.—S. WALES BRANCH: Grand Hotel, Cardiff, "Lubrication," by a technical representative of Vacuum Oil Company: together with a film entitled "The Inside Story," 7.30 p.m.

Thurs., Sept. 8th.—NEWCASTLE-UPON-TYNE BRANCH: Turks Head Hotel, Newcastle-upon-Tyne, "Materials Handling Equipment," L. Walmsley, 7.15 p.m.

Tues., Sept. 13th.—E. LANCS. BRANCH: Engineers' Club, Albert Square, Manchester, "Automatic Boiler Control," by a technical representative of Ronald Trist and Co., Ltd., 7.15 p.m.

Institute of Road Transport Engineers

Wed., Sept. 7th.—LONDON BRANCH: Visit to Shell Haven Refineries, 10.30 a.m.

Thurs., Sept. 15th.—N.E. CENTRE: Hotel Metropole, Leeds, "The Psychology of Diagnosis," R. B. Daniell, 7 p.m.

Institute of the Motor Industry

To-day, Sept. 2nd, to Sat., Sept. 10th.—St. Catherine's College, Cambridge, third annual summer school.

Institute of Welding

Thurs., Sept. 8th.—Visit to the Engineering and Marine Exhibition at Olympia, London, W.8.

Institution of Naval Architects

To-day, Sept. 2nd.—Autumn meeting, Copenhagen.

Institution of Production Engineers

Sat., Sept. 3rd.—BIRMINGHAM GRADUATE SECTION: The University, Bristol Road, Birmingham, Graduates' Conference on "Training and Leadership in Production Engineering," 9.15 a.m. to 5.30 p.m.

Wed., Sept. 7th.—WOLVERHAMPTON SECTION: Wolverhampton and Staffordshire Technical College Institute, Wolverhampton, "Atomic Physics," 7 p.m.

Thurs., Sept. 8th.—NOTTINGHAM SECTION: Visit to the Standard Motor Co., Ltd., Coventry, 9.30 a.m.

Fri., Sept. 9th.—W. WALES SUB-SECTION: Technical College, Swansea, "Air in Industry," C. W. Wheal, 7.30 p.m.

Tues., Sept. 13th.—MANCHESTER GRADUATE SECTION: College of Technology, Manchester, "Some Recent American Hydro-Electric Schemes, With Special Reference to Boulder Dam," W. A. Hatch, 7.15 p.m.

Contracts

BRITISH ELECTRICITY AUTHORITY announces that during the past month contracts have been placed for generation station, switching and transforming station and transmission equipment amounting in the aggregate to £1,828,440. The principal contracts include 132-kV and lower voltage cables Poole Generating Station (Pirelli General Cable Works, Ltd.); Structural steelwork for No. 3 section, Staythorpe Generating Station (Dorman, Long and Co., Ltd.); administration block superstructure, Croydon "B" Generating Station (Sir Robert McAlpine and Sons, Ltd.); structural steelwork, Accrington Generating Station (Simon Carves, Ltd.); 132-kV overhead line, East Yelland-Taunton (British Insulated Callender's Cables, Ltd.), and 33-kV 1000-MVA switchgear, Bolton Generating Station (British Thomson-Houston Company, Ltd.).

MECHANICAL HANDLING EXHIBITION, 1950.—The second Mechanical Handling Exhibition is to be held at Olympia, London, from June 6 to 17, 1950. The exhibition will be larger than the first one, the Grand Hall, Olympia, being used as well as the National Hall. Exhibits will cover the full range of equipment for the handling, lifting, stacking and short-distance transportation of goods, including trucks, conveyor and elevator systems, ropeways, cranes, hoists, winches, gears, chains, pallets and all accessories. Electronic control of lifting gear will be demonstrated. The exhibition is being organised by *Mechanical Handling*, and is supported by the Mechanical Handling Engineers' Association, the Industrial Truck Manufacturers' Association, the Association of Crane Makers, the Aerial Ropeways Association, and the Foundry Trade's Equipment and Supplies Association.

Personal and Business

MR. HAROLD STANDRING has been appointed personnel manager of Oldham and Son, Ltd., Denton, Manchester.

COLONEL G. G. H. BOLTON, marketing director of the North-Western Divisional Coal Board, has been appointed deputy chairman.

MR. E. H. DOUGHTY, A.M.I.Mech.E., has retired from the position of chief technical engineer of British Timken, Ltd., Aston, Birmingham.

GOUGH COOPER AND CO., Ltd., announces that one of its directors, Mr. W. R. Thomson, will be leaving shortly to visit the Associated Company in South Africa, Gough Cooper (Pty.), Ltd., Jubilee House, Simmonds Street, Johannesburg.

RICHARD CRITTALL AND CO., Ltd., announces that its main branch office for the North is at Martin's Bank, Water Street, Liverpool, under the control of Mr. J. P. Hamill. Another branch office is established at 93, Hope Street, Glasgow, C.3, with Mr. B. Jewell as manager. The offices of Richard Crittall Marine, Ltd., of which Mr. Hamill is managing director, are at 661, Royal Liver Building, Pier Head, Liverpool, 3.

British Standards Institution

All British Standard Specifications can be obtained from the Publications Department of the Institution at 28, Victoria Street, London, S.W.1.

SOUND RECORDING AND REPRODUCTION: MAGNETIC TAPE SYSTEMS FOR BROADCASTING

No. 1568: 1949. This standard, which has just been published, specifies requirements essential to secure satisfactory interchange of recordings on magnetic tape for broadcasting. The Standard provides definitions and deals with dimensions of tape, tape guides, tape speed, sense of winding, types of playing time of reels; it also specifies requirements for reels, for programme identification and for checking frequency response. This is the first of a series of Standards on magnetic sound recording, all of which will be published shortly and will together cover magnetic sound recording on film, tape, disc and wire. This first series of Standards is intended to provide an early basis for the design of new apparatus. When this first series has been completed, further British Standards will be published to deal with methods of test and requirements for magnetic sound-recording materials and equipment. Price 2s., post free.

TERMS AND DEFINITIONS APPLICABLE TO TIMBER, PLYWOOD AND JOINERY

No. 565: 1949. This Standard has recently been re-issued under the new title given above. The Standard has been considerably extended and now contains classified lists of terms in general use relating to forestry, structure, defects, sizes and quantities of timber and commercial abbreviations. Additional sections deal with terms relating to plywood and similar types of boards and to joinery. In the joinery section, the alternative terms used in Scotland and certain parts of the North of England are included where these differ from the terms in more general use. In addition to the terms which it is recommended should be adopted as standard terms, the glossary includes a number of alternative terms which are also in use in the timber industry. The Standard is arranged in sections so that related terms appear together as this is thought to be a more convenient method than a strict alphabetical arrangement. A comprehensive index is included to facilitate reference to any particular term. Price 5s., post free.

Books of Reference

Overseas Marketing Survey. Second edition. London: Business Publications, Ltd., 180, Fleet street, E.C.4. Price £3 3s.—In their constant endeavours to increase this country's export business, British manufacturers require as much up-to-date information as possible about overseas markets. The new and enlarged edition of this reference book will unquestionably prove valuable in this connection, for it presents very clearly a wealth of data relating to no less than eighty different countries. Trade prospects in those countries are carefully surveyed, and an analysis is given of the goods which they have imported in the last two or three years. The statistics included also cover such matters as population, standard of living, wage rates, and industrial production. Moreover, such useful particulars as those relating to travel and transport facilities, currency, import licensing and customs tariff have not been overlooked. Some specially contributed articles, with which the "Survey" opens, and which deal with various aspects of export procedure, are another helpful feature. As the Secretary for Overseas Trade comments in a Foreword to the book, "even the experienced world trader finds it increasingly difficult to get a full and accurate picture of his potential market on which to base a sales campaign." This "Survey" certainly fills in, in a convenient form, much of that picture.

Britannica Book of the Year, 1949. London: Encyclopædia Britannica, Ltd., 90, Dean Street, W.1. Price 50s.—For the first time since 1939, Encyclopædia Britannica, Ltd., is able to publish this volume which provides an annual summary of world events of the preceding year. The 1949 issue has been compiled by 457 leading authorities. The historical, political and economic events of 1948 recorded are chiefly notable for the steps taken to end the economic decline in Britain and Europe which was largely the legacy of World War II. The Year Book also records developments in industry, science, the arts, the humanities, religion, law and sport, and contains biographies of the outstanding personalities of the year.

Reports on German and Japanese Industry

Limited numbers of copies of the reports of Intelligence Objectives Sub-Committees on German and Japanese Industry listed below can be obtained from H.M. Stationery Office at the prices stated.

B.I.O.S. OVERALL REPORT No. 21: "THE MOTOR-CAR INDUSTRY IN GERMANY DURING THE PERIOD 1939–1945."—This report has been prepared by Mr. Maurice Olley, chief research engineer, Vauxhall Motors, Ltd., with a contribution on German racing cars by Mr. Cameron C. Earl. The report covers all aspects of the motor-car industry and includes sections under the following headings: Private Cars, "Volkswagen," Trucks and Commercial Vehicles, Public Service Vehicles, Motorcycles and Autocycles, and Tractors.

The German motor-car industry was never fully mobilised, since the intention was to preserve it intact to facilitate its reconversion to peacetime production after the victorious end of a short war. By 1940, therefore, the private car and motor-cycle branches of the industry had practically collapsed, and although the manufacture of half-tracked vehicles was started in 1940, even in 1944 the German army was still using a large percentage of standard civilian trucks. Research continued throughout the war and in a few directions was ahead of progress in this country.

The section on racing cars gives details of the development and design of the Mercedes-Benz and Auto-Union Grand Prix racing cars. Although these developments received government backing, the subsidies were entirely inadequate to cover the costs of the programmes. Great interest attaches to the arguments advanced by Mercedes and Auto-Union engineers, respectively, for and against forward or rear engine mounting. Data sheets are given for the various G.P. machines.

The report contains eleven pages of references to German reports and documents on the subject. Price 2s, post free.

Technical Information and Documents Unit, German Division, Board of Trade, 40, Cadogan Square, S.W.1, which has at its disposal a considerable volume of information not in a form suitable for general reproduction, is prepared to receive enquiries regarding all problems relating to scientific and technical intelligence on both German and Japanese industry.

LECTURES AT THE BUILDING TRADES EXHIBITION.—The Prestressed Concrete Development Group of the Cement and Concrete Association has arranged a course of lectures on prestressed concrete which will be given each evening at 6 p.m. in the National Hall Gallery Lecture Room, Olympia, during the Building Trades Exhibition in November. The first lecture will be on Thursday, November 17th, by P. G. Bowie, with the title "General Principles of Prestressed Concrete," and the lectures listed below will be delivered on each succeeding evening (except Sundays) until Wednesday, November 30th:—"The Magnel System and its Application," by D. H. May; "High-Strength Concrete for Prestressed Work," by A. R. Collins; "The Freyssinet System and its Applications," by A. J. Harris; "The Architectural Use of Prestressed Concrete," by L. W. Elliott; "The Preload System," by L. S. G. Homewood; "Ministry of Works' Experimental Work on Prestressed Concrete," by H. Kaylor; "Hoyer Method of Prestressed Concrete and its Development in this Country," by D. H. New; "The Application of Prestressing to Shell Roof Construction," by H. G. Cousins; "Prestressed Concrete Factory at Bristol," by C. W. Glover; "The Dow-Mac System of Manufacture of Prestressed Concrete," by R. S. V. Barber, and "Application of Prestressing to Some Special Structures and Conclusions," by P. G. Bowie. Admission to the lectures will be by ticket only; tickets for all or any one of the lectures may be obtained from the Secretary, Prestressed Concrete Development Group, 52, Grosvenor Gardens, S.W.1, or, during the time the exhibition is open, to the stand of the Cement and Concrete Association (No. 250, Row O), National Hall, Olympia.